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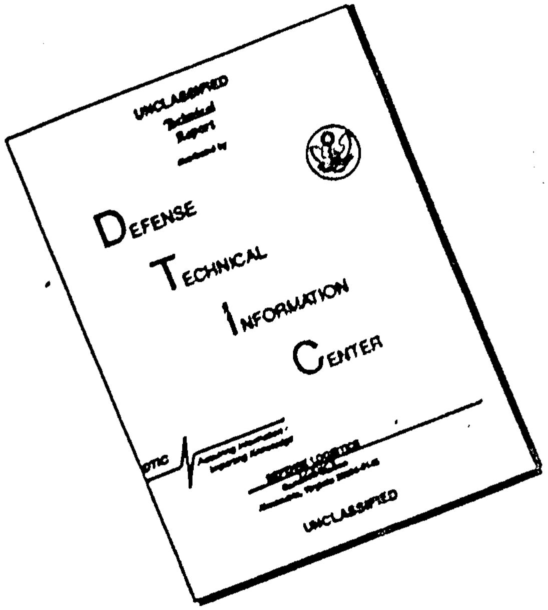

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WIND TUNNEL TEST OF SEVERAL DUCTED PROPELLERS IN NON-AXIAL FLOW

CONTRACT NO. Nonr 1357(00)

PHASE IV

Report No. ARD-224

April 20, 1959

WIND TUNNEL TESTS OF SEVERAL DUCTED
PROPELLERS IN NON-AXIAL FLOW
Contract No. Nonr 1357(00), Phase IV

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ADVANCED RESEARCH
DIVISION OF HILLER AIRCRAFT CORPORATION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

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LIST OF FIGURES (cont.)

SUMMARY

Wind tunnel and static tests were conducted on various ducted propellers of 2.0 foot diameter at the David Taylor Model Basin. Measurements were made of the total aerodynamic forces and moments, the forces and moments acting on the duct itself, and the power supplied to the propellers. The model was tested at advance ratios (tunnel airspeed/propeller tip speed) of 0, 0.05, 0.10 and 0.15 with the duct axis tilted through a range of angles between 0 and 90 degrees. Detailed velocity surveys were conducted in the slipstream, and vanes mounted in the slipstream were tested. In addition, centerbodies of the type used in flying platforms were investigated.

Four ducts were tested in combination with three different sets of contra-rotating, adjustable-pitch propellers. Three of the ducts had airfoil profiles (one with an exit diffuser), and the fourth consisted of a circular cylinder with a bell-mouth inlet formed by a lemniscate curve. Three of the ducts had chord-to-diameter ratios of 0.25 and one of 0.15. One set of the contra-rotating propellers had 2 twisted blades per propeller; another had 3 twisted blades per propeller, and the third had 3 constant chord, untwisted blades per propeller.

The data are presented in the form of coefficients based on propeller tip speed, duct area and propeller radius, except for the duct alone (ring wing) data, for which the coefficients are based on tunnel airspeed. Slipstream flow survey data are presented in tabular form.

The highest figure of merit, 1.07, (based upon an ideal value of $\sqrt{2}$) was obtained with the bell-mouth duct in combination with a set of twisted, 3-bladed, contra-rotating propellers at a blade pitch angle of approximately 19 degrees at 0.7 of blade radius. The duct in this configuration carried a higher percent of the total thrust (46 percent) than did any of the other ducts tested. The other propeller-duct combinations developed considerably lower maximum figures of merit (as low as 65 percent of the above) and these occurred at correspondingly lower optimum propeller blade pitch angles ($\beta \approx 16$ degrees at 0.7 of blade radius). The percentage of total thrust carried by the duct decreased approximately to 30 percent for the longer chord airfoil profile ducts, and to 18 percent in the case of the shorter chord duct. The three airfoil profile ducts incurred separation of the airflow over the inlet lip. This separation or stall is evidently the primary cause of the comparatively poor performance of the airfoil type ducts.

The bell-mouth duct in general exhibited the highest forward flight efficiencies (or equivalent lift/drag ratios) and developed the largest total pitching moment and total lift coefficients when compared with the other ducts. The bell-mouth duct was the only configuration of the four ducts tested for which inlet lip stalling did not occur in forward flight at the tilt angles corresponding to equilibrium (i.e., propulsive force coefficient = 0). The forward flight results showed that the highest forward flight efficiency was obtained at the lower propeller blade pitch angles (10 to 16 degrees, depending upon the advance ratio) than the optimum for the static figure of merit. The configurations exhibiting low pitching moments also had low static and forward flight efficiencies.

The exit vanes showed little effectiveness for lowering the tilt angle or pitching moment at the condition of equilibrium (propuslive force coefficient = 0).

1. INTRODUCTION

The possibilities afforded by the use of ducted propellers for aircraft propulsion were first demonstrated by Luiga Stipa in Italy in 1930 (Reference 1). Stipa's experiments showed sizable gains in efficiency at low speeds with duct axis parallel to the free stream. In 1944, an extensive study of ducted propellers in axial flow was conducted by Kruger in Germany (References 2 and 3). When it was realized that these gains are lost at higher speeds, owing to the drag of the duct, interest in this type of propulsive unit waned. It was not until the development of lighter, more powerful engines, which made hovering flight and vertical take-off feasible, that interest in the ducted propeller was revived. Here the emphasis was not on increased propulsive efficiency at high speed, but rather on increased static thrust for hovering. In 1948, Platt, of the NACA, (Reference 4) made full-scale tests which showed a remarkable increase in static thrust per horsepower over the open propeller.

The application of the ducted propeller to aircraft which are to be capable of both hovering and forward flight naturally raises the question of the behavior of the ducted propeller when tilted with respect to the flight direction. More recently, wind tunnel data for a ducted propeller in nonaxial flow have been published by Parlett (Reference 5). Limited full-scale data were obtained for a specific configuration by Hiller Aircraft Corporation in 1954 (Reference 6).

In order to obtain more experimental data on a variety of ducted propeller configurations in both static and forward flight (nonaxial flow) conditions, the present wind-tunnel program was included as part of the work in Phase IV of Contract No. Nonr 1357(00), which was jointly sponsored by the Army and Navy. Also, the data were to be used to obtain stability derivatives for the calculation of dynamic stability and control responses for the 7 foot diameter flying platform, Model 1031-A-1. The test program was conducted at the David Taylor Model Basin in the return section (17 x 20 feet) of the "south" 8 x 10 Subsonic Wind Tunnel (see Reference 7). Tests were made for the static condition (both inside and outside the tunnel) and for three advance ratios at various tilt angles and propeller blade settings sufficient to cover the maximum efficiency conditions for each configuration.[1]

---

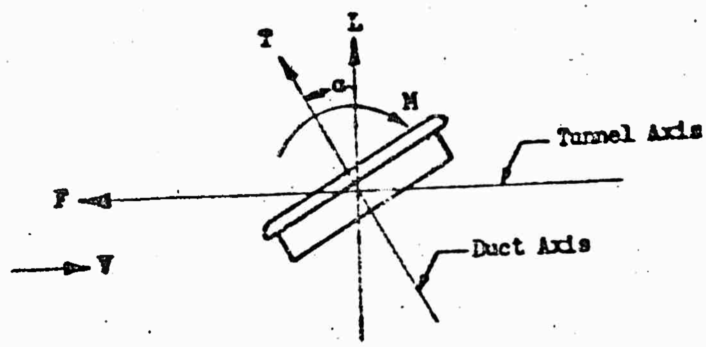
[1] During the progress of the present program, results of additional ducted propeller experiments in nonaxial flow have become available (see References 8 and 9).

Independent force and moment measurements were obtained both for the duct in the presence of the propellers (with the electric motor housing in the slipstream) and for the total model. Also measured were the model power and the slipstream flow characteristics.

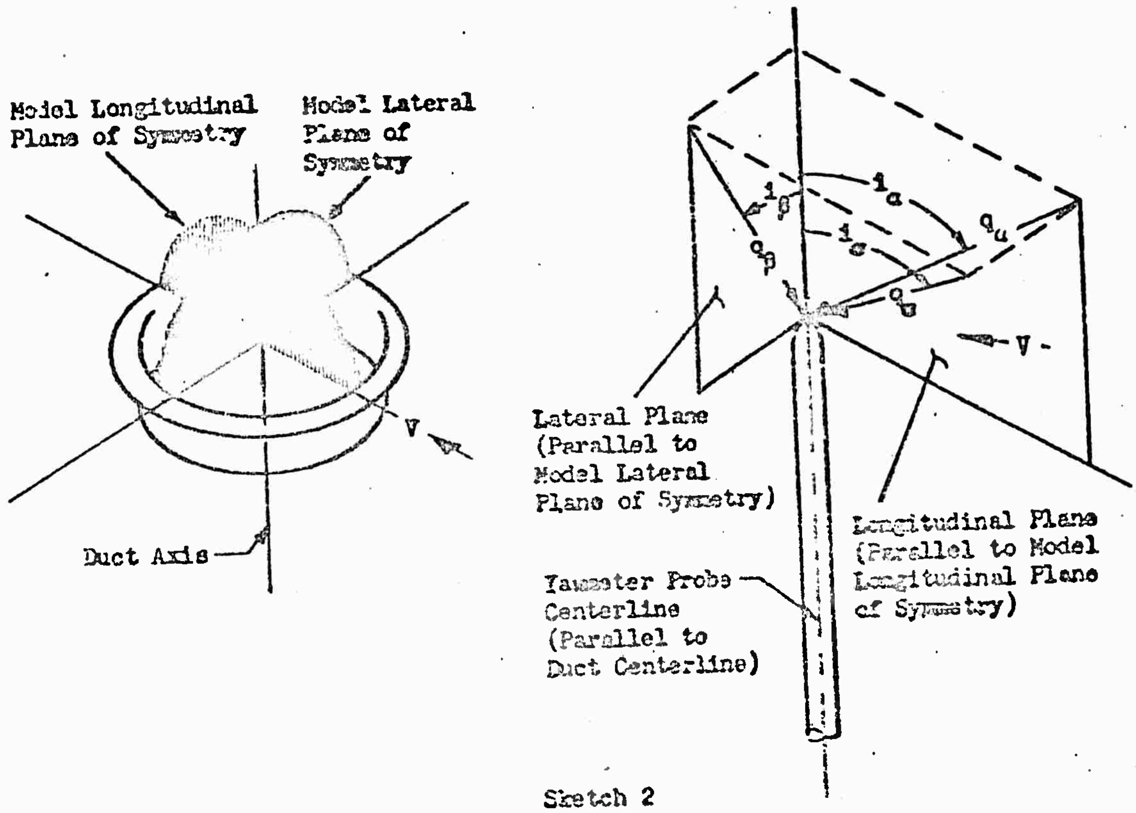
The reduced test data have been plotted in non-dimensional coefficient form, except for the slipstream characteristics, which have been tabulated in terms of local flow angularity and local dynamic pressure.

2. NOTATION

Positive directions for forces, moments, and angles are shown in the following sketches.



Sketch 1



Sketch 2

A	=	Duct minimum inside area, πR^2, ft^2
B	=	Simulated platform engine (see Figure 3)
C_F	=	Total propulsive force coefficient, $\frac{F}{\frac{1}{2}\rho V^2 A}$
C_{F_D}	=	Duct propulsive force coefficient, $\frac{F_D}{\frac{1}{2}\rho V^2 A}$
C_L	=	Total lift coefficient, $\frac{L}{\frac{1}{2}\rho V^2 A}$
C_{L_D}	=	Duct lift coefficient, $\frac{L_D}{\frac{1}{2}\rho V^2 A}$
$C_{M_{\ell/4}}$	=	Total pitching moment coefficient about duct quarter chord, $\frac{M}{\frac{1}{2}\rho V^2 AR}$
$C_{M_{D_{\ell/4}}}$	=	Duct pitching moment coefficient about duct quarter chord, $\frac{M_D}{\frac{1}{2}\rho V^2 AR}$

(Coefficients C_F through $C_{M_{D_{\ell/4}}}$: Coefficients based on tunnel airspeed)

$c_{.7R}$	=	Propeller blade chord at 0.7 radius station, in
D	=	Duct minimum inside diameter, ft
D_1	=	Duct No. 1, Modified NACA 6421 profile (see Table 1)

D_2 = Duct No. 2, NACA 0018 profile (see Table 2)

D_3 = Duct No. 3, Modified lemniscate profile (see Table 3)

D_4 = Duct No. 4, Modified NACA 6421 profile (short chord) (see Table 4)

E = Electric motor and housing in duct inlet

F = Total propulsive force, lb (parallel to tunnel axis, positive upstream)

F_D = Duct propulsive force, lb

H = Dummy electric motor housing (see Figure 3)

Coefficients based on propeller tip speed:

k_F = Total propulsive force coefficient, $\dfrac{F}{\rho(\Omega R)^2 A}$

k_{F_D} = Duct propulsive force coefficient, $\dfrac{F_D}{\rho(\Omega R)^2 A}$

k_L = Total lift coefficient, $\dfrac{L}{\rho(\Omega R)^2 A}$

k_{L_D} = Duct lift coefficient, $\dfrac{L_D}{\rho(\Omega R)^2 A}$

$k_{M_{\ell/4}}$ = Total pitching moment coefficient about duct quarter chord $\dfrac{M}{\rho(\Omega R)^2 AR}$

$k_{M_{D_{\ell/4}}}$ = Duct pitching moment coefficient about duct quarter chord, $\dfrac{M_D}{\rho(\Omega R)^2\, AR}$

k_{M_P} = Propeller pitching moment coefficient about midpoint between front and rear propeller shank centerlines (reference lines, see Table 6), $\dfrac{M_P}{\rho(\Omega R)^2\, AR}$

k_P = Power coefficient, $\dfrac{P}{\rho(\Omega R)^3\, A}$

k_T = Total thrust coefficient, $\dfrac{T}{\rho(\Omega R)^2\, A}$

k_{T_D} = Duct thrust coefficient, $\dfrac{T_D}{\rho(\Omega R)^2\, A}$

Coefficients based on propeller tip speed

L = Total lift, lb (perpendicular to tunnel axis, positive as shown in Sketch 1)

L_D = Duct lift, lb

ℓ = Duct chord length, ft

ℓ_P = Distance between duct leading edge and shank centerlines (reference line) of the rear propeller blades, in (see Table 6)

ℓ_Y = Distance between duct trailing edge and yawmeter total pressure orifice, in

M = Figure of merit, $\frac{T}{P}\sqrt{\frac{T/A}{2\rho}}$ (ideal value = $\sqrt{2}$ with no diffuser, according to simple momentum theory)

M = Total pitching moment, ft-lb (positive when tending to decrease α; see Sketch 1)

M_D = Duct pitching moment, ft-lb

M_P = Propeller pitching moment, ft-lb

N = Total number of blades in a set of contra-rotating propellers

P = Input power, ft-lb/sec

P_P = Constant chord, untwisted, 3-bladed, contra-rotating (paddle-blade) propellers

P_2 = Twisted, 2-bladed, contra-rotating propellers

P_3 = Twisted, 3-bladed, contra-rotating propellers

P_3' = Twisted, 3-bladed, single-rotating propeller (P_3 with rear propeller removed)

q_α = Component of local slipstream dynamic pressure lying in a longitudinal plane, lb/ft^2 (see Sketch 2)

q_β = Component of local slipstream dynamic pressure lying in a lateral plane, lb/ft^2 (see Sketch 2)

q_σ = Local slipstream dynamic pressure, lb/ft^2 (see Sketch 2)

R = Duct minimum inside radius, ft

r	=	Polar coordinate of lemniscate inlet, in (see Table 3)
RPM	=	Propeller rotational speed, rev/min
ΔR	=	Average clearance between duct and propeller tips, in
S	=	Propeller hub spinner
T	=	Total thrust, lb, (parallel to propeller axis, positive as shown in Sketch 1)
T_D	=	Duct thrust, lb
$t/c_{.7R}$	=	Propeller blade thickness ratio at the propeller 0.7 radius station
V	=	Wind tunnel airspeed, ft/sec
$V_{(\ )}$	=	Exit vanes (subscript denotes vane deflection angle)
X	=	Distance along duct chord line from leading edge of airfoil profile ducts, in
Y_I	=	Ordinate of duct inner surface measured perpendicular to duct profile chord line, in
Y_O	=	Ordinate of duct outer surface measured perpendicular to duct profile chord line, in
α	=	Tilt angle, deg (angle between duct axis and the normal-to-the-tunnel axis, positive when tilted forward as shown in Sketch 1)
β	=	Propeller blade pitch angle at 0.7 radius station, deg

δ = Exit vane deflection angle, deg (positive when tending to increase tilt angle)

ε = Forward flight efficiency (or equivalent lift/drag ratio), $\frac{LV}{P-FV}$

θ = Polar coordinate (angle) of lemniscate inlet, deg (see Table 3)

i_α = Local slipstream angle in longitudinal plane, deg (see Sketch 2)

i_β = Local slipstream angle in lateral plane, deg (see Sketch 2)

i_σ = Local slipstream angle relative to duct axis, deg (see Sketch 2)

λ = Advance ratio, $\frac{V}{\Omega R}$

ρ = Air mass density, slug/ft^3

σ = Propeller solidity, $\frac{N\, c_{.7R}}{\pi R}$

ϕ = Azimuth angle of yawmeter rake, deg (see Table 7)

Ω = Propeller rotational speed, rad/sec

3. DESCRIPTION OF MODEL, TEST APPARATUS AND TEST PROCEDURES

3.1 Model

The basic ducted propeller model tested was made up of interchangeable 2-foot diameter ducts or shrouds and contra-rotating propellers which were powered through a transmission of 1/1 reduction by a 75 horsepower, water-cooled, variable-frequency electric motor. A general arrangement drawing of the model is shown in Figure 1.

3.1.1 Ducts

Four 2-foot diameter duct shapes were tested. The profile ordinates, orientation with respect to the propeller axis, and general physical characteristics are presented in Tables 1, 2, 3, 4, and 5. Three of the ducts (D_1, D_2, and D_4) had airfoil section profiles. Two of the ducts (D_1 and D_4) had the same airfoil section (NACA 6421) but had chord lengths of 6.0 and 3.6 inches, respectively. These airfoils were modified and oriented in such a manner as to eliminate any diffusion angle (see Tables 1 and 4). The third duct of this group (D_2) had an NACA 0018 airfoil section of 6.0 inch chord length, which was oriented to give a diffuser effect (see Table 2). The fourth duct (D_3) had an inlet inside contour formed by a section of a lemniscate curve which became parallel to the duct axis. The duct had a total chord length of 6.0 inches (see Table 3).

The ducts were constructed of laminated Honduras mahogany with an imbedded steel ring for strength and to provide attachment to the support system. The ring in each case was located in the area of the propeller planes. Four lugs extended from the ring through the outside surface of the ducts for attachment to the support system (see Figure 1).

3.1.2 Propellers and Hubs

Three different sets of contra-rotating propellers were designed and tested. Two of these sets, 2 blades per propeller and 3 blades per propeller, used the same chord and twist distribution (see Table 6) and an RAF-6, 12 percent thick blade section. The third propeller configuration had a set of 3-bladed, contra-rotating propellers whose blades were untwisted and had a constant-chord RAF-6, 12 percent thick section. Physical characteristics of these three propeller configurations appear in Table 5. The front propeller rotated clockwise when viewed from the duct inlet.

The propeller blades were fabricated at the David Taylor Model Basin from aluminum alloy on a profile machine which utilized a six-times enlarged pattern of the blades as a model. The constant-chord (paddle) blades were made by using the 30 percent radius station of the pattern for the twisted blades (see Table 6).

Two sets of steel split hubs were made to accommodate the 2-bladed and 3-bladed contra-rotating propellers (see Figure 2). Provision was made in the hubs to vary the propeller diameter and the propeller blade pitch angle. The propellers could also be positioned axially in the ducts.

3.1.3 Exit Vanes

Two exit vanes were fabricated from steel sheet stock which was bent to form a symmetrical 15 percent thick airfoil section of 0.20 foot chord. These vanes were located and secured to the duct support system as shown in Figure 1. The vane deflections were adjustable through ± 22 degrees with respect to the duct axis.

3.1.4 Spinner and Inlet Centerbodies

The model had a propeller hub spinner 5.12 inches long and 4.12 inches maximum diameter as shown in Figure 7. A dummy of the electric motor housing was fabricated in order to determine the aerodynamic interference due to the presence of the electric motor housing in the slipstream. Also, a model of a flying-platform engine installation was made in order to determine the effects of this type of blockage in the duct entrance (see Figure 3).

The original method of attachment for the hub fairing and the dummy of the electric motor housing (see Figure 1a) had to be abandoned as a result of bearing failures. The stationary mounting shaft was removed, and a spinner was attached directly to - and rotated with - the front hub. The dummy electric motor housing was attached to the main duct support arms as shown in Figure 3.

3.1.5 Model Motor

The model was powered by a water-cooled, variable-frequency electric motor rated at 75 horsepower at 12,000 rpm and 32.9 foot pounds of torque. The motor was mounted in a housing which was connected to the rear of the transmission as shown in Figure 1.

3.1.6 Transmission

A transmission of 1:1 gear ratio converted the rotation from the electric motor shaft to the two contra-rotating shafts. It was designed to permit variation of the axial location of the propellers in the duct. For this purpose, the duct support system was connected to a movable ring which fitted around the transmission; the ring was retained by a lock nut on either side (see Figures 1 and 4).

3.2 Support System

The model was mounted on its side on a vertical shaft, so that changes in tilt angle were achieved by rotation about the vertical axis. The base stand was mechanized to rotate the vertical shaft in either direction by remote control. The method of model attachment is shown in Figure 1, and the orientation of the model in the tunnel is shown in Figure 5. In order to permit independent measurement of he forces and moments acting on the duct as distinguished from those acting on the entire model, the duct was mounted independently of the propellers and motor. This was accomplished by means of instrumented arms connecting the ring on the transmission to the duct lugs.

In order that the water, electric strain gage, and tachometer leads for the motor would not transmit any aerodynamic forces or moments to the model, all leads were routed through a fairing that extended from the support housing for the vertical shaft to the rear of the motor (see Figure 3a).

3.3 Instrumentation

The model was instrumented with strain gages in such a way that, in addition to the total aerodynamic forces and moments acting on the complete model (including the electric motor housing), the forces and moments acting on the duct itself could be obtained simultaneously.

3.3.1 Measurements of Aerodynamic Forces and Moments

The total axial and normal forces were obtained from strain-gaged sections in bending on the main vertical shaft, as shown in Figure 1b. Owing to the way in which the model was mounted, any pitching of the model would tend to rotate the vertical support shaft; thus, the total model pitching moment was measured by a strain-gage beam which resisted any rotation of the vertical shaft (see Figure 1b). The axial and normal forces acting on the duct were obtained from the bending of four strain-gaged sections in the two cross members (see Figure 1b).

3.3.2 Measurements of Drive System Power

The electric motor was instrumented for torque in order that input power to the propellers could be determined. This was accomplished by attaching a strain-gage beam to the rear of the motor which restrained the motor from rotating (not shown in Figure 1a). The motor was also instrumented for measuring bearing temperatures by means of thermocouples at both ends of the motor. The motor rpm was indicated by means of a tachometer. The motor was remotely controlled from the tunnel control room by a variable-frequency console. The transmission temperature was measured by means of a thermocouple installed at the rear of the transmission.

3.3.3 Fouling of Propeller - Duct

Fouling between propeller and duct was detected electrically by painting the inside of the ducts in the area of the propeller planes with conductive silver paint. Leads connected this painted area and the model drive system to an oscilloscope. When contact was made between the duct and propellers, it was indicated by a signal on the oscilloscope in the control room. At this signal, the operator immediately stopped the motor.

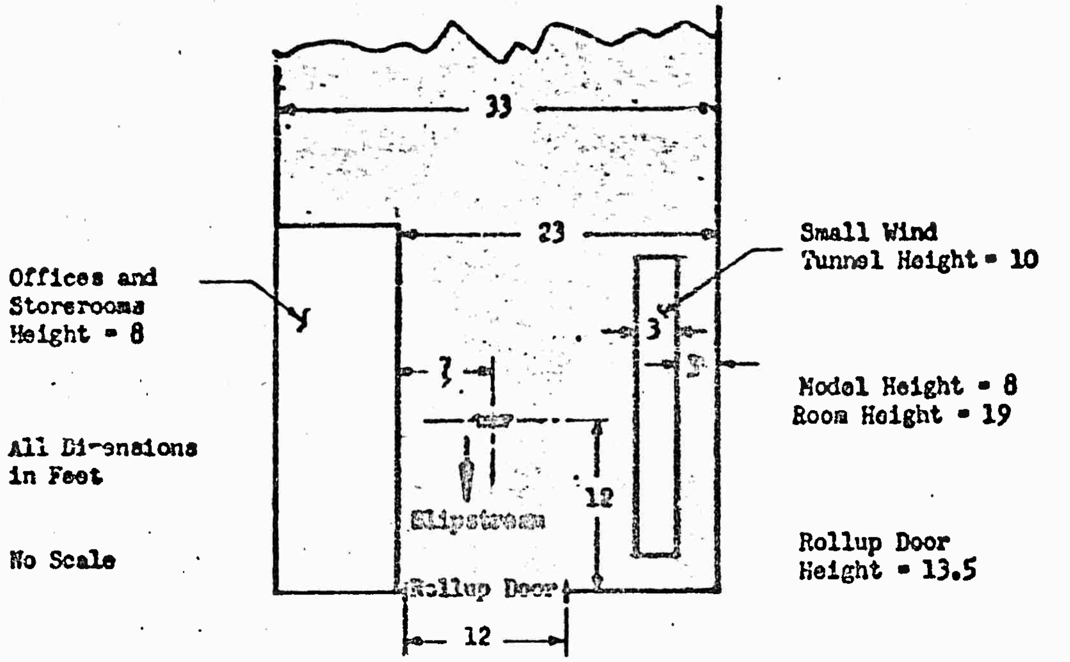
3.3.4 Measurements of the Slipstream

The characteristics of the flow in the slipstream were investigated in a separate series of tests by means of a 6-probe yawmeter rake. The rake was attached to the motor housing in such a way that it could be rotated to various azimuth angles and moved over a range of longitudinal positions, as shown in Table 7. The rake tubes were connected to an alcohol manometer board where the pressure levels were recorded photographically.

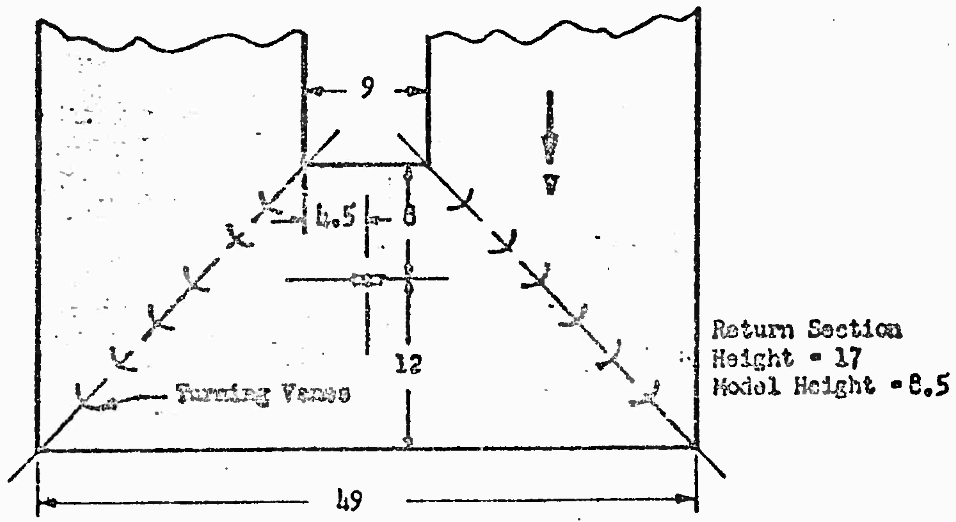
3.4 Static Test Set-Up

The static tests were conducted in an open room (see Figure 6). The model axis was located approximately 3-1/2 duct diameters away from the nearest wall and exhausted toward the opening for the large overhead door in one wall of the room. Sketch 3 shows the relative position of the model in the open room and also its position in the wind tunnel.

In the preruns of the test program, it was found that the propellers touched the ducts when power was supplied to the model, making it necessary to mount the ducts asymmetrically (with power off) about the propeller axis to avoid this trouble. It was also



3a Open Room



3b Wind Tunnel Return Section

Sketch 3 Plan View of Model in Open Room and in Wind Tunnel Return Section

It was also found that more consistent results were obtained if the electric motor and transmission were allowed to warm up at 3960 rpm before taking data.

3.5 Static Test Procedure

The model was operated at motor speeds of 5600, 4850, 3960, 2800, and 1252 rpm with propeller blade pitch angles at 0.70 of blade radius from 9 to as high as 27 degrees, depending on the duct being tested. The maximum propeller blade tip Mach number at 5600 rpm was about 0.5.

When there were any unusual variations in the strain gage indicator readings, or when the variation between the final and initial indicator readings were greater than 1 percent of full anticipated load, the test was rerun until satisfactory data were obtained.

As each run was being made, the figures of merit for the previous run were calculated and plotted against propeller rpm. Successively higher propeller blade pitch angles were investigated until it became apparent that the maximum figure of merit could be determined.

3.6 Forward-Flight Test Set-Up

The forward-flight tests were conducted in the return section of the DTMB "south" Subsonic Wind Tunnel, which had been successfully utilized before in helicopter rotor-system testing. The model was located approximately 4 duct diameters away from the nearest wall of the 17 x 20 foot return section, as shown in Sketch 3. The velocity distribution in and around the area occupied by the model was determined prior to the model installation, and the local velocity was found to be within ± 2 percent of the mean value in the central area. The maximum velocity obtainable in the return section (with model installed) was approximately 62 feet per second, yielding a maximum Reynolds number of 0.37×10^6 per foot of length.

The model was aligned with the air flow in the test section by observing at what tilt angle the total pitching moment was zero. At this point the model was considered to be in axial flow, and the tilt angle counter was set at 90 degrees.

3.7 Forward Flight Test Procedure

The operating procedure for the wind tunnel tests was to maintain a constant dynamic pressure (q) in the test area for each of the desired advance ratios (λ). These conditions were met by setting the proper tunnel dynamic pressure, calculating the tunnel airspeed, and changing the motor rpm to obtain the required advance ratio. The operating conditions are shown below:

λ	q lb/ft^2	V ft/sec	RPM	α Range deg	β Range deg
.05	.468	20	3960	-10 to 30	9 - 27
.10	1.885	41	3960	10 to 40	9 - 27
.15	4.294	62	3960	20 to 70	9 - 27

approximate values

A limited number of runs were made at other conditions as follows:

λ	q lb/ft^2	V ft/sec	RPM	α Range deg
.075	1.056	31	3960	-10 to 30
.125	2.962	51	3960	10 to 40
.050	.727	26	4920	20 to 70

approximate values

The model was operated at successively higher tilt angles in 10 degree increments until the tilt angle for equilibrium (that is, for $k_P = 0$) was exceeded by 15 to 20 degrees. Around the condition of equilibrium, the tilt angle was varied in 5 degree increments. In addition, whenever apparent discontinuities occurred, smaller tilt angle increments were investigated in the affected region.

For a given model configuration, a sufficient range of propeller blade pitch angles was tested so that the forward flight efficiency reached a maximum value at the equilibrium condition ($k_P = 0$) and started to decrease as higher blade pitch angles were investigated.

Shortly after the forward flight portion of the test program was started, the model met with two accidents. The model consisting of Duct 3 in combination with a set of twisted, 2-bladed, contra-rotating propellers and exit vanes ($D_3P_2SV_5$) was being brought up to speed, when it stopped for no apparent reason. Upon investigation, it was found that the propellers had been bent and twisted in the hub in such a manner that the front and rear propellers locked together. A photograph of the damaged model is shown in Figure 9. Fortunately, the duct was not damaged beyond several scratches on the inner surface, and it was easily repaired, but the propellers were damaged beyond repair, and a new set of blades had to be fabricated. In the second accident involving the same configuration without vanes, the propellers gouged the inner wall of the duct in several places, causing damage of such a nature that the duct had to be removed for repairs.

As minor difficulty with the 2-bladed propellers had already been experienced prior to these two accidents, it was decided that further detailed testing with this propeller configuration was detrimental to the total program. Therefore, such testing was limited to testing at one blade angle through the advance ratio and tilt angle ranges for each of the remaining ducts.

3.8 Data Corrections

A check run was made with the tunnel turned off to determine what effect the presence of the tunnel walls might have on the model static performance through a range of tilt angles. Comparison with the static results obtained outside the tunnel indicated that the model (D_3P_3S) exhibited very slight differences in its aerodynamic characteristics. This might be expected because of the relatively low disk loading (approximately 25 lb/ft^2) and the large size of the wind tunnel return section. The model occupied only about 1 percent of the test area. For this reason, the tunnel wall effects were considered to be small, and no attempt was made to apply tunnel wall corrections of any kind.

Duct 4, with a set of twisted, 3-bladed, contra-rotating propellers, was tested over a range of $\pm$ 20 degrees from the axial flow attitude. From these tests, the flow alignment in the tunnel appears to be good.

The loss in model thrust due to the presence of the duct support system in the slipstream has been calculated (with drag coefficient estimated to be 0.7) to be 1.5 percent. This is well

within the estimated overall accuracy of the data and has not been included as a correction to the data.

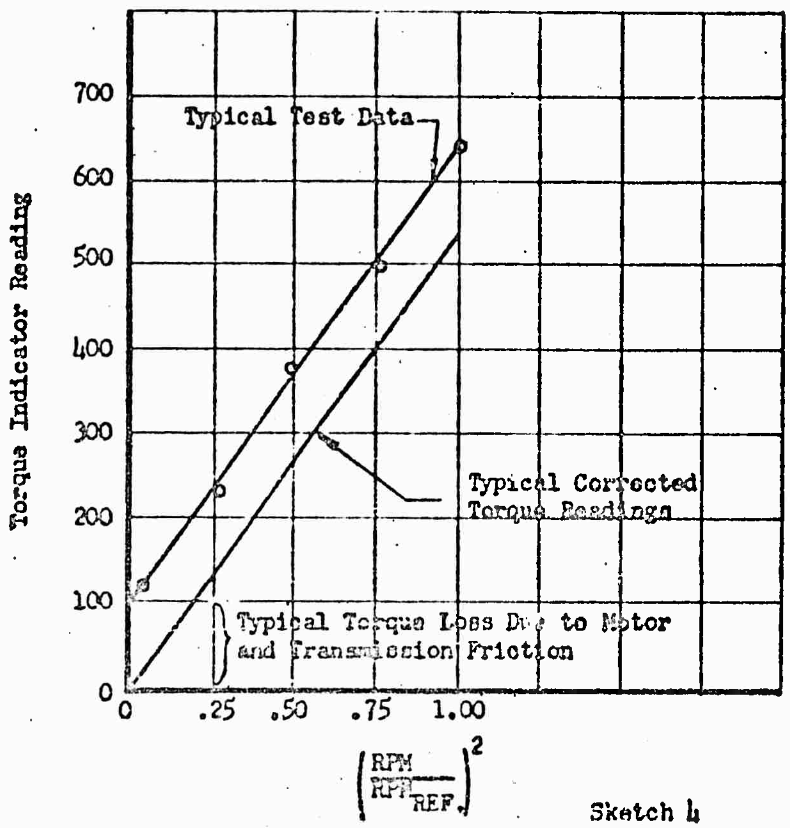
A series of tests were performed to obtain an indication of the aerodynamic interference caused by the presence of the electric motor housing in the slipstream. This was accomplished by rearranging the model so that the electric motor and housing were in the duct entrance. The model was then tested with and without a dummy of the electric motor housing in the slipstream. As will be seen later, the model characteristics were little affected, and any correction that might be made for the presence of the electric motor housing in the slipstream of the model will be left to the individual analyst, since the appropriateness of such a correction must depend upon the particular application.

The temperature of the transmission increased 60 to 70 degrees Fahrenheit when operated in the tunnel as compared to its operation in the open room. Therefore, in order to lower the transmission temperature to a safe operating range, the forward flight portion of the test program was run at 3960 rpm instead of 5600 rpm as originally planned. This lower rpm reduced the accuracy of the data, because the gage drift and high tunnel temperature effects now became a greater percent of the total measured loads.

Following each run, the frictional losses of the motor and transmission were estimated by operating the model at various rotational speeds, measuring the corresponding torque, and plotting these values of torque (torque indicator readings) against a squared rpm scale (see Sketch 4). The torque necessary to overcome the friction of the system was indicated from the plot by the value of the torque indicator reading when extrapolated to zero rpm. This value of friction torque was assumed to be constant with motor speed, so that the indicated reading at zero rpm was subtracted from all torque readings as a correction for the frictional losses of the electric motor and transmission.

It should be noted that the spinner rotates with the front propeller hub, and such phenomena as magnus effect (see Reference 10) and boundary layer build-up caused by the rotating spinner may be present to alter the performance of the ducted propeller. No attempt has been made to predict these effects.

The average deviation of the instrumentation readings used to calculate the aerodynamic and power coefficients is estimated to be approximately ± 2 percent of maximum indicator readings. The tilt angles and propeller blade pitch angles were set within ± 0.2 degrees. The motor rpm was considered to be within ± 1 percent.



Sketch 4

4. DISCUSSION OF RESULTS

The plotted data are divided into 3 groups: (1) static performance characteristics, (2) total forward flight characteristics, and (3) duct forward flight characteristics. All coefficients are based upon propeller tip speed (except for duct-alone or ring-wing characteristics), minimum inside duct area, and minimum inside duct radius. In addition, the slipstream characteristics are tabulated in terms of local flow angularity and local dynamic pressure.

4.1 Static Performance Characteristics

The static data taken in the large room and inside the tunnel are plotted against propeller blade angle for various rpm in Figures 11 through 43. These data consist of total thrust coefficient, duct thrust coefficient, power coefficient, figure of merit, and ratio of duct thrust to total thrust. The total pitching moment and propulsive force coefficients are included on the plots containing configurations with exit vanes.

Figure of merit is used as the measure of static efficiency and is defined as

$$M = \frac{T}{P}\sqrt{\frac{T/A}{2\rho}}$$

so the ideal value as given by simple momentum theory is $\sqrt{2}$ for a ducted propeller with no diffuser. It should be noted that this same equation is used for the efficiency of an open rotor for which the ideal value is 1.0. Thus, a comparison of the two types of propulsive systems can be made directly in terms of thrust per horsepower at a given disk loading.

The conditions designated 1, 2, and 3 in the legend on static plots (Figures 25 through 43) for data taken inside the wind tunnel correspond to static measurements taken after the wind tunnel was turned off, following a run at a given advance ratio. The conditions indicated are as follows:

Condition 1 - after a λ = .05 run at 3960 rpm

Condition 2 - after a λ = .10 run at 3960 rpm

Condition 3 - after a λ = .15 run at 3960 rpm

Condition 4 - Static run outside tunnel at 3960 rpm

Where a comparison is made with the outside-of-the-tunnel data, a curve is drawn through the Condition 4 data.

For all configurations tested, the total thrust, duct thrust, and total power coefficients increase as the propeller blade angle increases from the minimum setting. The figure of merit, however, increases to a maximum (at an optimum blade setting for the particular configuration being tested) and then decreases as the propeller blade angle increases further.. It is interesting to note that configurations having a higher maximum figure of merit also have a higher ratio of duct thrust to total thrust, as predicted by theory.

Propeller rpm evidently has little or no effect on the thrust coefficients, but there is a slight variation in the power coefficient, causing the figure of merit to vary as much as 10 percent.

The highest figure of merit for each duct is obtained with a set of twisted, 3-bladed, contra-rotating propellers. Duct 3 yields the highest figure of merit attained in these tests (1.07 at a propeller blade angle of roughly 19 degrees,[2] Figure 13); the maximum figure of merit for the poorest hovering duct (Duct 4) is 0.72 at a propeller blade angle of approximately 17 degrees (see Figure 14); Ducts 1 and 2 both exhibit maximum figures of merit of about .79 at a propeller blade angle of approximately 16 degrees (Figures 11 and 12). The maximum figure of merit for the same propeller without a duct is 0.68.

At the maximum figure of merit the portion of the total static thrust carried by each duct depends on the duct shape. The bell-mouth duct develops 46 percent of the total thrust, the highest of all the ducts, whereas the shorter chord duct develops the least amount, 18 percent, of the total thrust. Ducts 1 and 2 each carry about 30 percent of the total thrust.

Changes in propeller planform and solidity appear to be less important, in the present tests, than changes in duct shape. That is, a comparison of Figures 27, 31, and 42 indicates that replacing the 3-bladed, contra-rotating propellers (P_3) in Duct 3 with the 2-bladed, contra-rotating propellers (P_2), or with the 3-bladed, single

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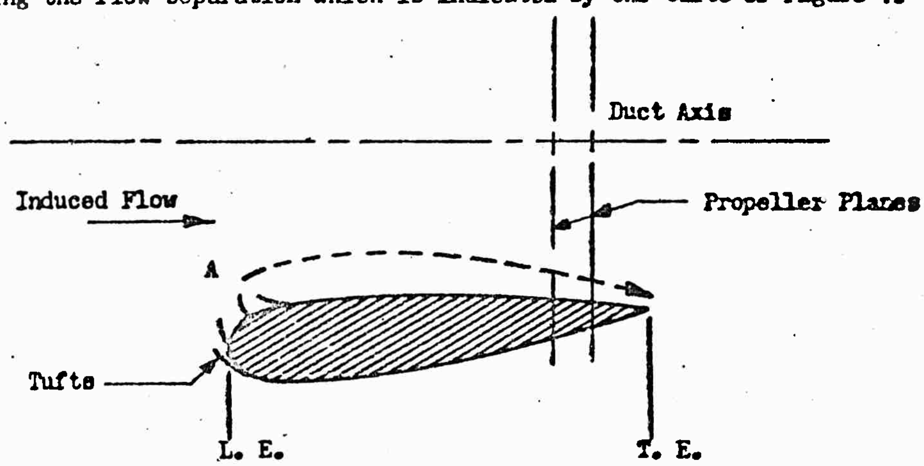
[2]Actually, the curves are so flat that the optimum blade angles cannot be accurately determined, considering the estimated accuracy of the data.

rotation propeller (P_3'), caused a loss of only a few percent in figure of merit. The combination of the bell-mouth duct (D_3) with the untwisted paddle blades (P_P) produced a figure of merit somewhat lower than that for the same duct with the twisted blades (see Figures 13 and 21). Both of these changes (i.e., solidity and blade planform) showed even smaller effects when tested in combination with a less efficient duct (D_2).

In order to investigate the cause of the low static efficiencies and thrust attained with the airfoil-type ducts, a limited tuft study was made of the flow around the duct lip in static operation. A typical flow pattern on the lip of one of the airfoil-profile ducts is shown in Figure 7. Sketch 5 has been prepared as an aid in visualizing the flow separation which is indicated by the tufts of Figure 7.



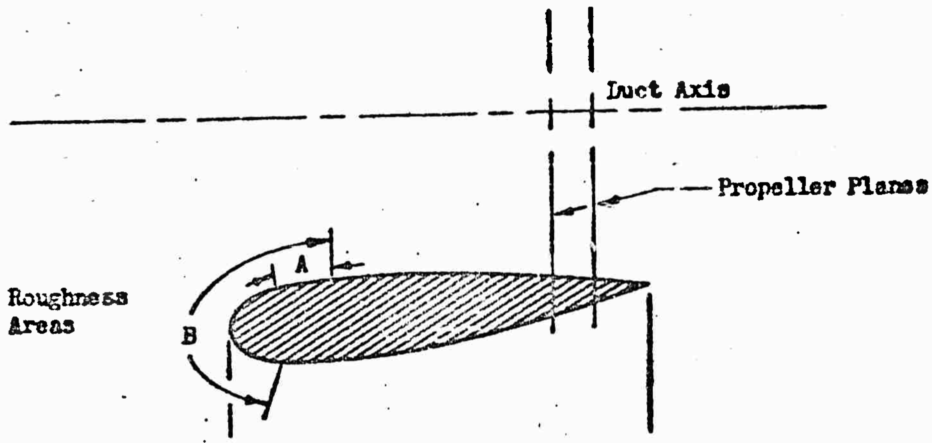
Sketch 5

It should be noted that the direction of flow on both the inside and outside duct surfaces is towards the leading edge of the duct. These two flows meet at the separation area marked "A" and evidently turn into the duct as indicated by the dashed arrow.

This region of separated flow is further indicated on the above configuration by the oil pattern observed on the inside surface of the duct, as shown in Figure 8. The oil came from a leak in the transmission and was throw radially to the duct by the rear propeller in the area indicated in the figure. The oil then proceeded forward through the front propeller as seen from the photographs.

Tufts placed on Duct 3 were observed to lie flat against the duct surface and indicated completely attached flow all the way around the duct leading edge. Thus, it appears that the three airfoil ducts (D_1, D_2, and D_4) are stalled in static operation, and the bell-mouth duct (D_3) is unstalled.

A few static tests were made with transition fixed by incorporating roughness areas of various widths on the lip of Duct 2, as shown in Sketch 6.



Sketch 6

The results of this limited roughness investigation are shown in Figure 20. It can be seen that the added roughness areas have no effect on the model performance.

Figures 36, 37, and 38 show that the presence of the exit vanes and centerbodies have little effect on the model static characteristics.

Figures 39, 40, and 41 show the effects of propeller tip clearance and propeller location in the duct. It can be seen that independently increasing the propeller tip clearance or moving the propellers forward from their normal location has little effect on the static characteristics. However, when the two adjustments are made at the same time, the figures of merit are decreased as much as 10 percent.

In order to investigate the effect of the tunnel walls on the model static characteristics, the D_3P_3S configuration was tested (with tunnel

turned off) through a tilt angle range of 0 to 90 degrees with a propeller blade setting of 12 degrees. The results of this test are shown in Figure 43 as a function of tilt angle, and show only slight variations which are well within the accuracy of the data.

4.2 Total Forward Flight Characteristics

The forward flight data are divided into three major parts. In the first part, shown in Figures 44 to 103, the total aerodynamic forces and moments, the power supplied to the model, and the forward flight efficiency are plotted for a given propeller pitch angle as functions of tilt angle, with advance ratio as a parameter. In the second part, Figures 104 to 181, the aerodynamic forces and moments are plotted for a given tilt angle as functions of advance ratio, with propeller pitch angle as a parameter. In the third part, Figures 182 to 238, the aerodynamic forces and moments acting on the duct itself (at the same conditions, with the propeller operating) are plotted for a given propeller pitch angle as functions of tilt angle with advance ratio as a parameter.

Within each of these three parts, the figures are presented in groups, such as Duct 1 in combination with the twisted, 3-bladed, contra-rotating propellers and spinner (D_1P_3S), Duct 2 in combination with the twisted, 3-bladed, contra-rotating propellers and spinner (D_2P_3S), etc. Each configuration was tested for a series of propeller blade pitch angles, with each pitch angle investigated over a range of tilt angles and advance ratios.

In general, the ducts in combination with a set of 3-bladed, contra-rotating propellers show that the power coefficients remain unchanged as the tilt angle varies, decrease slightly at higher advance ratios, and increase with an increase in propeller blade pitch angle (see Figures 44 through 61). The forward flight efficiencies tend to peak at some tilt angle, but exhibit increasing values with an increase in advance ratio. For the airfoil profile ducts it can be seen in Figures 44 through 61 and 104 through 120 that the total lift and pitching moment coefficients tend to peak as the tilt angle and advance ratio increase, but they always become larger as the propeller blade pitch angle increases. The bell-mouth duct lift and pitching moment coefficients evidently tend to peak as tilt angle increases, but they increase steadily as advance ratio and propeller blade pitch angle increase. The propulsive force coefficient increases in value as the tilt angle and propeller blade pitch angle increase; increasing the advance ratio decreases the propulsive force coefficient.

In general, Duct 3 with the twisted, 3-bladed, contra-rotating propellers (D_3P_3S) exhibits a greater forward flight efficiency than

the other three configurations. The maximum pitching moment coefficient of the bell-mouth duct (D_3P_3S) is from 3 to 5 times those of the other three duct configurations. The equilibrium tilt angles (angles at which $k_p = 0$) are smallest for the shorter chord duct configuration (D_4P_3S) and greatest for the larger chord airfoil profile ducts.

In summary, the configuration having the highest static efficiency also develops the highest forward-flight efficiency, experiences the largest pitching moments, and requires lower equilibrium tilt angles (angle at which $k_p = 0$) than the airfoil profile ducts of the same duct chord/diameter ratio.

Limited tuft studies were conducted on the ducts in forward flight. Typical duct lip conditions are shown in Figures 10a through 10d for Duct 1 in combination with a set of twisted, 3-bladed, contra-rotating propellers. These studies indicate that the flow inside the airfoil profile ducts is separated in forward flight.

It should be noted that the straight portion of the tufts lying circumferentially are fastened to the duct with transparent tape.

In Figures 62 through 67 and 121 through 127, the performance characteristics of the various ducts in combination with a set of twisted, 2-bladed, contra-rotating propellers are presented and show much the same variation as the ducts with the twisted, 3-bladed, contra-rotating propellers. The magnitudes of the lift, pitching moment, and power coefficients are slightly lower for the 2-bladed propeller configuration; on the other hand, forward flight efficiency is somewhat higher, and the propulsive force coefficient is unchanged. At the highest advance ratio for the 2-bladed propeller configurations tested in Duct 3, a discontinuity occurs in the variations of lift and pitching moment coefficients and forward flight efficiency with tilt angle. This discontinuity appears to be caused by reattachment of the flow on the duct at a critical tilt angle.

The test results for the paddle-blade propeller configuration in combination with Ducts 2 and 3 are presented in Figures 68 through 70 and 128 through 133. In general, a comparison of the results for the ducted, paddle-blade propellers with those for the ducted, twisted, 3-bladed propellers indicates that, for a given propeller blade angle and advance ratio, the former develops greater lift and pitching moment, requires more power, and produces lower propulsive force and forward flight efficiency than the latter.

The characteristics of the unshrouded propeller (P_3S) are presented in Figures 71 through 73 and 134 through 144. Comparing the open propeller with the same propeller in combination with Duct 3 at equal propeller blade angles, it can be seen that, in general, the addition of the duct reduces the power required, increases the maximum forward flight efficiency and provides approximately 12 percent increase in maximum lift. The tilt angle of the ducted propeller for the condition of equilibrium ($k_F = 0$) is substantially greater, and the total pitching moment values are several times those of the open propeller configuration.

The installation of exit vanes with Duct 3 in combination with a set of twisted, 3-bladed, contra-rotating propellers has no effect on forward flight efficiency or on the power and propulsive force coefficients. However, the pitching moment coefficient is slightly lowered and the lift coefficient increased. The vane effectiveness over the range of deflections tested is seen to be small in Figures 74 through 79 and 145 through 150. The 2-bladed, contra-rotating propellers in combination with Duct 3 and exit vanes were tested at a vane deflection of zero, and the results are shown in Figures 80 and 151.

The characteristics of Duct 3 in combination with the twisted, 3-bladed, propellers and pilot dummy (D_3P_3H), and of the same configuration (see Figure 3) in combination with the simulation of the platform engines (D_3P_3HB), are presented in Figures 81 through 86 and 152 through 159. The lift and power coefficients are of the same magnitude as those for the same model without centerbodies. However, the pitching moment coefficient is higher owing to the added drag of the bodies and their location relative to the moment reference point of the model. The forward flight efficiency and propulsive force coefficient are slightly changed.

In order to check the aerodynamic effects attributable to the presence of the electric motor housing in the slipstream, the model was reassembled so that the electric motor and housing were in the duct entrance (D_4P_3E). This model was tested with and without the dummy electric motor housing (H) placed in the slipstream. The presence of the dummy electric motor housing in the slipstream did not change the lift and power coefficients, but did lower the propulsive force and pitching moment coefficients and forward flight efficiency slightly (see Figures 87, 88, 160 and 161). No correction to the data has been made for the presence of the electric motor housing in the slipstream, since the appropriateness of such a correction must depend upon the particular application.

The effects of tip clearance and propeller location for Duct 3 in combination with a set of twisted, 3-bladed, contra-rotating propellers are presented in Figures 89 through 94 and 162 through 172, for propeller blade pitch angles of 12 and 18 degrees. A change of propeller tip clearance from 0.046 to 0.088 inches (i.e., from 0.2 to 0.4 percent of duct diameter) with the propellers in their normal location (ℓ_p = 5.13 inches) tends to lower all coefficients and efficiency for both blade pitch angles. Moving the propellers forward from their normal location with the normal tip clearance of 0.046 inches causes variations in the model performance which depend upon the blade pitch angle tested. Simultaneously moving the propellers forward from their normal location and increasing the propeller tip clearance from 0.046 to 0.088 inches tends to lower the lift and pitching moment coefficients as well as the forward flight efficiency. The power and propulsive force coefficients change only slightly due to these propeller adjustments.

A single-rotation, 3-bladed propeller (P_3') was formed by removing the rear propeller from the twisted, 3-bladed, contra-rotating set of propellers. The results of testing this propeller (which was located 2.58 inches from duct leading edge) in combination with Duct 3 are shown in Figures 95 through 98 and 173 through 177. The characteristics of this configuration ($D_3P_3'S$) vary in the same manner as those for Duct 3 with the twisted, 3-bladed, contra-rotating propellers. The power, lift and pitching moment coefficients for the single rotation propeller are lower, and the forward flight efficiency is higher than with the contra-rotating propellers. The propulsive force coefficient is of the same magnitude. A change in tip clearance from 0.046 to 0.088 inches at a propeller blade angle of 30 degrees shows that the aerodynamic coefficients are slightly lowered, but the forward flight efficiency and power coefficient are unchanged.

Figures 99 and 178 through 181 show the axial flow performance of Duct 4 in combination with a set of twisted, 3-bladed, contra-rotating propellers. It is worth noting that the symmetry of these curves indicates good alignment of the flow with the tunnel axis.

An increase in propeller rpm from 3915 to 4920 at a low advance ratio, using Duct 3 in combination with a set of twisted, 2-bladed, contra-rotating propellers shows no effect on the lift and power coefficients or on the forward flight efficiency (Figure 100). However, the pitching moment and propulsive force coefficients are increased.

The aerodynamic characteristics of Ducts 1, 3, and 4 without propellers (i.e., ring-wing data) in the presence of the electric motor housing are shown in Figures 101, 102, and 103, respectively,

for a tunnel airspeed of approximately 62 ft/sec. The coefficients in these plots are based on tunnel airspeed. It should be noted here that the tilt angle employed in the presentation of these data is 90 degrees out of phase with the standard manner of presenting ring-wing data; that is, a tilt angle of 90 degrees corresponds to an axial flow condition or zero angle of attack. Thus, it can be seen that the aerodynamic coefficients vary as expected; i.e., the lift and drag build up as the angle of attack is increased until the stall is reached; they experience an abrupt change at this point owing to flow separation on the duct.

4.3 Duct Forward Flight Characteristics

The lift, propulsive force, and pitching moment coefficients of the ducts in the presence of the operating propellers and electric motor housing are plotted against tilt angle in Figures 182 through 238. Each plot is for a constant propeller blade pitch angle (unless otherwise noted) with advance ratio as a parameter.

Comparing Duct 3 with the other ducts in the presence of a set of twisted, 3-bladed, contra-rotating propellers in Figures 182 through 199, it is found that Duct 3 develops maximum lift coefficients up to twice those of Ducts 1 and 2, and up to 3.5 times that of Duct 4. Duct 3 produces several times the maximum pitching moment coefficients of the other ducts, and propulsive force coefficients slightly higher than Ducts 1 and 2. The magnitudes and slopes of the propulsive force coefficients for Ducts 3 and 4 are comparable for the tilt angles shown.

The characteristics of the ducts in the presence of the twisted, 2-bladed, contra-rotating propellers, shown in Figures 200 through 205, vary in much the same manner as with the twisted, 3-bladed, contra-rotating propellers. However, the ducts in the presence of the 2-bladed propeller configuration show lower lift and pitching moment coefficients. Slightly higher propulsive force coefficients are produced for Ducts 1, 2, and 4, and the magnitudes and slopes of the propulsive force coefficients for the two propeller configurations in Duct 3 are such that they cross. The discontinuities that appeared in the total lift and pitching moment curves for the models with the twisted, 2-bladed, contra-rotating propellers appear in the duct curves at the same conditions, tending to verify that these ducts have separated flow at the lower tilt angles.

Ducts 2 and 3 were tested in the presence of the paddle-blade, contra-rotating propellers. The results, presented in Figures 206, 207, and 208, show that the paddle-blade propeller configuration produces higher pitching moment and lift coefficients and lower propulsive force coefficients than does the twisted, 3-bladed propeller configuration.

The characteristics of the duct with exit vanes installed on the model are presented in Figures 209 through 215. The duct propulsive force and lift coefficients are unaffected by the presence of the exit vanes, and the pitching moment coefficients are only slighty affected.

Figures 216 through 221 present the duct characteristics in the presence of the twisted, 3-bladed, contra-rotating propellers and the centerbodies (D_3P_3H and D_3P_3HB). The presence of the centerbodies in the duct inlet alters only slightly the duct aerodynamic coefficients.

The characteristics of Duct 4 with the electric motor housing in the duct inlet, both with and without the dummy electric motor housing (D_4P_3E and D_4P_3HE) in the model slipstream, are shown in Figures 222 and 223. The duct characteristics are apparently unaffected by the presence of the motor housing in the slipstream.

Figures 224 through 229 show the effect of moving the propellers axially from their normal chordwise position in the duct to the forward position. It can be seen that this change tends to lower the duct lift and pitching moment coefficients, as does increasing the propeller tip clearance from 0.046 to 0.088 inches with the propellers at their normal chordwise position. The propulsive force coefficients are unaffected by these propeller adjustments. When the tip clearance is increased at the same time that the propellers are moved to the forward position, the values of lift and pitching moment are reduced by approximately the sum of the effects of the individual propeller adjustments. The propulsive force coefficients are unchanged.

The duct characteristics in the presence of the 3-bladed, single rotating propeller ($D_3P_3'S$) are shown in Figures 230 through 233. Comparing this propeller configuration with the twisted, 3-bladed, contra-rotating propellers, it is found that the duct pitching moment and lift coefficients are lower, and the duct propulsive force is higher. Increasing the tip clearance of this propeller from 0.046 inches to 0.088 inches at a blade pitch angle of 30 degrees lowers the duct lift and pitching moment coefficients but does not change the duct propulsive force coefficient.

The duct characteristics for D_4P_3S in axial flow are shown in Figure 234.

The change in the duct characteristics for the D_3P_2S configuration due to increasing propeller rotational speed from 3915 to 4890 rpm at an advance ratio of 0.05 is shown in Figure 235. The lift and propulsive

force coefficients are not affected, but the pitching moment coefficient is decreased.

The duct-alone (ring-wing) characteristics for Ducts 1, 3, and 4 without propellers at a tunnel airspeed of approximately 62 ft/sec are presented in Figures 236, 237 and 238. A comparison of the duct forces and moments (propellers removed), Figures 236, 237, and 238, with the total forces and moments (propellers removed), Figures 101, 102, and 103, shows the electric motor housing and spinner to have large effects in the absence of the propellers.

4.4 Slipstream Characteristics

Measurements of the local flow angularity and dynamic pressure in the slipstream were made at 5 azimuth locations and 2 axial positions (Table 7) for Duct 3 in combination with a set of twisted, 3-bladed, contra-rotating propellers (D_3P_3S) at various tilt angles, advance ratios and propeller blade angles. The local slipstream angles and components of local dynamic pressure in planes parallel to the model longitudinal and lateral planes of symmetry are presented in Table 8. The slipstream data is left in tabular form, since the particular use of the data would dictate the form in which it should be plotted.

5. CONCLUSIONS

The wind tunnel test program was conducted to investigate the aerodynamic, power, and slipstream characteristics of various ducted propellers in static and forward flight conditions. Following are some of the conclusions resulting from that program:

5.1 Static

1. Of the configurations tested, the bell-mouth duct in combination with a set of twisted, 3-bladed, contra-rotating propellers yielded the highest figure of merit, 1.07, which was approximately 57 percent higher than the maximum figure of merit of 0.68 obtained for the same propeller without a duct. This figure of merit for the ducted propeller apparently occurred at a propeller blade pitch angle of roughly 19 degrees at the 0.7 radius station, although the curve of figure of merit vs. blade angle was actually quite flat.

2. The two larger chord, airfoil type ducts produced maximum figures of merit of about 0.79 at a blade pitch angle of about 16 degrees. The shorter chord duct produced a maximum figure of merit of 0.72 at a blade pitch angle of 17 degrees. It can be seen that the addition of the short chord duct provided very little improvement over the open propeller.

3. Flow separation over the duct lip was observed in the static condition for all of the airfoil profile ducts tested. This inlet flow separation or stall is considered to be the primary cause of the relatively poor static performance of these ducts.

4. The twisted, 3-bladed, contra-rotating propellers produced slightly higher maximum figures of merit for each duct tested than did the twisted, 2-bladed, contra-rotating propellers. A set of constant chord, untwisted, 3-bladed, contra-rotating propellers exhibited a maximum figure of merit somewhat lower than that for the twisted, 3-bladed, contra-rotating propellers in combination with the same ducts.

5. At the optimum propeller blade angle, the bell-mouth duct carried 46 percent of the total static thrust, and the two large-chord airfoil ducts carried about 30 percent of the total static thrust. The small-chord airfoil duct carried only 18 percent of the total static thrust.

6. The static characteristics of the ducted propeller configurations were essentially unaffected by the presence of the tunnel walls, except in the case of the bell-mouth duct configuration, in which the thrust carried on the duct was slightly reduced by the presence of the tunnel walls.

5.2 Forward Flight

1. The bell-mouth duct configuration in general developed the highest forward flight efficiency (or equivalent lift/drag ratio) and the highest lift and pitching moment coefficients at the condition of equilibrium ($k_F = 0$). Only the shorter chord duct showed smaller equilibrium tilt angles (angle at which $k_F = 0$) than the bell-mouth duct configuration.

2. The three airfoil profile ducts tested were found to have flow separation at the duct inlet lip for tilt angles corresponding to forward flight equilibrium ($k_F = 0$).

3. The exit vanes showed little effectiveness in lowering either the tilt angle or the pitching moment at the condition of equilibrium ($k_F = 0$).

4. The presence of the electric motor housing in the exit had no effect on the lift and power coefficients, and only slightly lowered the propulsive force and pitching moment coefficients, and increased the forward flight efficiency and tilt angle for equilibrium ($k_F = 0$).

5. Increasing the clearance between the propeller tips and the duct lowered the values of all coefficients and of the forward flight efficiency. Moving the propellers forward in the duct caused different variations in the model performance, depending upon the propeller blade angle. The combination of the widest tip clearance and most forward propeller location produced lower lift and pitching moment coefficients and lower forward flight efficiency. The power and propulsive force coefficients were changed only slightly.

6. The bell-mouth duct in the presence of the propellers and the electric motor housing in the slipstream developed maximum duct lift coefficients up to twice those of the longer airfoil ducts, and up to 3.5 times that of the shorter airfoil duct. The bell-mouth duct developed several times the maximum pitching moment coefficients of the other ducts, and slightly higher propulsive force coefficients. The duct force and pitching moment coefficients were altered by the various model changes and adjustments in much the same manner as were the total force and moment coefficients.

7. The aerodynamic characteristics of the ducts without propellers (i.e., ring-wing data) varied as might be expected; i.e., the lift and drag built up as the angle of attack increased until the stall was reached. An abrupt change was experienced at this point, owing to flow separation on the duct.

6. REFERENCES

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TABLE 1

DUCT 1 ORDINATES AND ORIENTATION
MODIFIED NACA 6421 SECTION

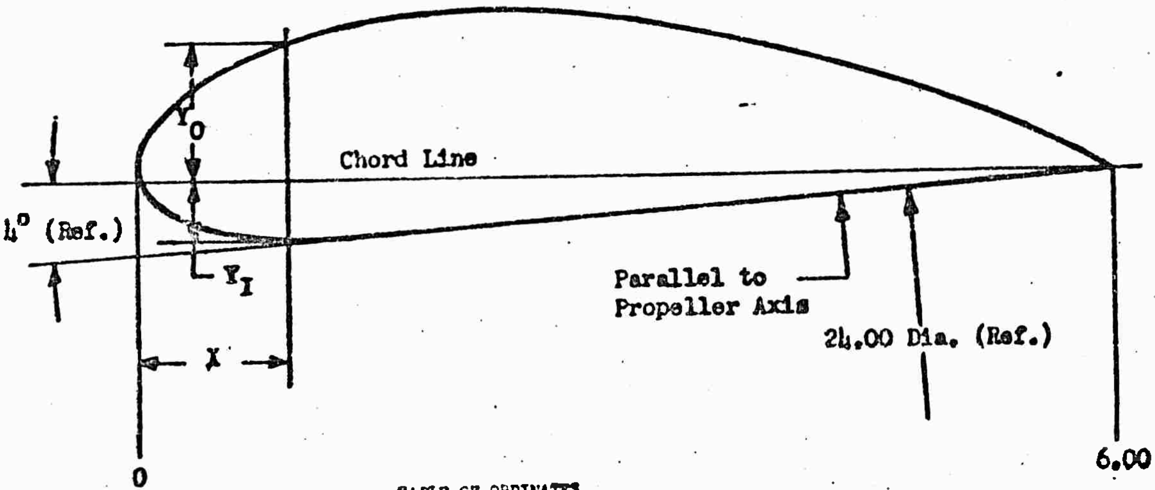


TABLE OF ORDINATES

L.E. Radius = .291
Slope of Radius Thru
End of Chord = 3/10

CHORD X (in.)	OUTER ORDINATE Y_O (in.)	INNER ORDINATE Y_I (in.)
0		0
.075	.308	-.125
.15	.396	-.182
.30	.518	-.250
.45	.615	-.289
.60	.692	-.311
.90	.806	-.331
1.20	.886	-.329
1.50	.938	-.314
1.80	.970	
2.40	.970	
3.00	.910	
3.60	.806	
4.20	.664	
4.80	.485	
5.40	.272	
5.70	.148	
6.00		0

Straight Line Between these Points

TABLE 2

DUCT 2 ORDINATES AND ORIENTATION
NACA 0018 SECTION

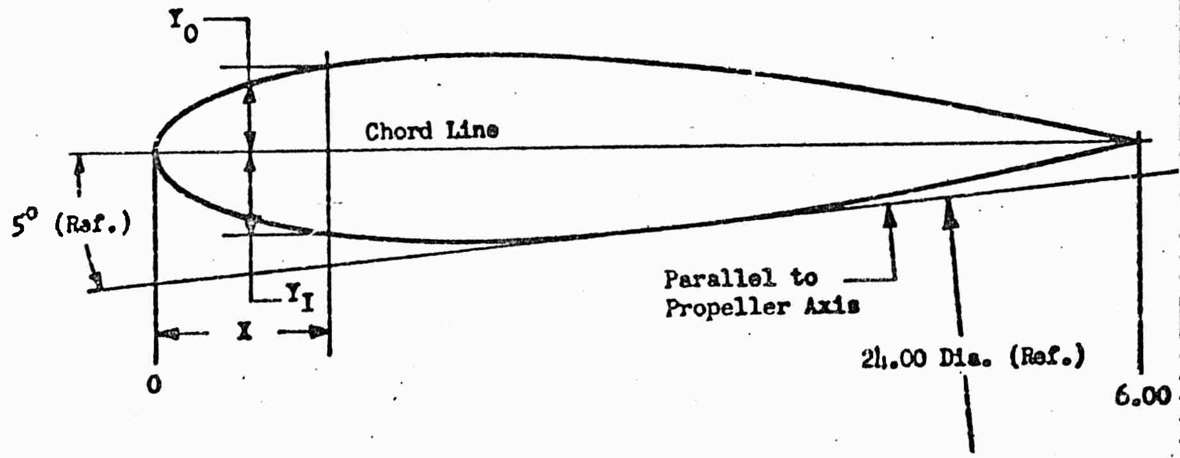


TABLE OF ORDINATES

L.E. Radius = .214

CHORD X (in.)	OUTER ORDINATES Y_O (in.)	INNER ORDINATE Y_I (in.)
0	0	0
.075	.170	-.170
.15	.237	-.237
.30	.320	-.320
.45	.378	-.378
.60	.422	-.422
.90	.481	-.481
1.20	.516	-.516
1.50	.535	-.535
1.80	.540	-.540
2.40	.523	-.523
3.00	.477	-.477
3.60	.411	-.411
4.20	.330	-.330
4.80	.236	-.236
5.40	.132	-.132
5.70	.073	-.073
6.00	0	0

TABLE 3

DUCT 3 ORDINATES AND ORIENTATION
MODIFIED LEMNISCATE CURVE

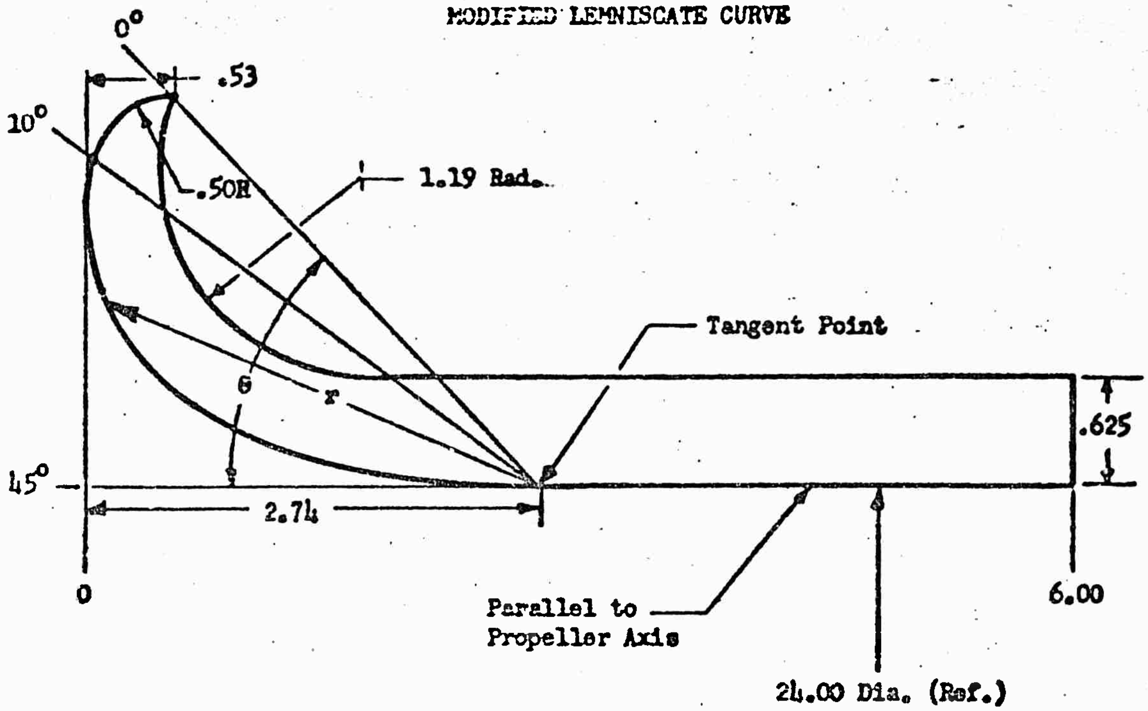


TABLE OF ORDINATES

θ DEGREES	r INCHES
0	3.39
3	3.38
6	3.36
10	3.27
15	3.16
20	2.99
25	2.72
30	2.40
33	2.16
36	1.89
38	1.67
40	1.41
41	1.27
42	1.10
43	0.90
43.5	0.78
44	0.63
44.5	0.45
44.75	0.31
45	0

The radii between θ of 0° and 10° modified by an arc of a circle whose radius is 0.50 as shown above.

TABLE 4

DUCT 4 ORDINATES AND ORIENTATION
MODIFIED NACA 6421 SECTION

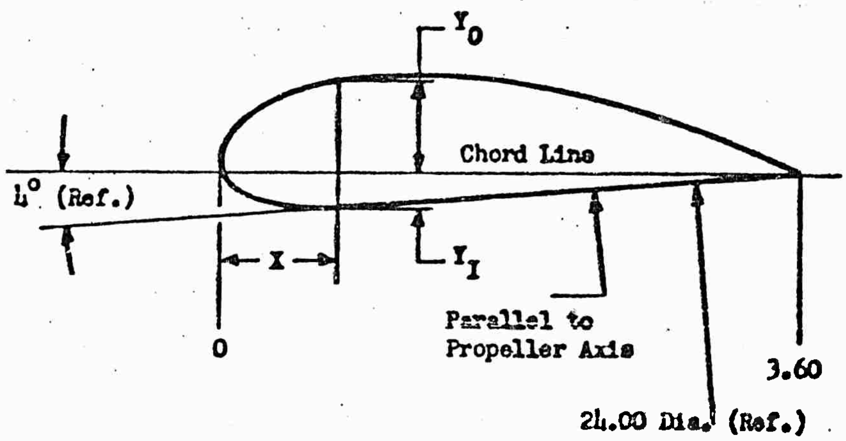


TABLE OF ORDINATES

L.E. Radius = .175
Slope of Radius Thru
End of Chord = 3/10

CHORD X (in.)	OUTER ORDINATE Y_O (in.)	INNER ORDINATE Y_I (in.)
0		0
.045	.185	-.075
.090	.238	-.109
.180	.311	-.150
.270	.369	-.173
.360	.415	-.186
.540	.484	-.199
.720	.532	-.198
.900	.563	-.188
1.080	.581	
1.437	.582	
1.800	.545	
2.156	.484	
2.520	.398	
2.875	.291	
3.240	.162	
3.420	.089	
3.600		0

Straight Line
Between these Points

TABLE 5

PHYSICAL CHARACTERISTICS OF MODEL

DUCT	1	2	3	4
Minimum Inside Radius, ft.	1.00	1.00	1.00	1.00
Minimum Inside Area, sq. ft.	3.14	3.14	3.14	3.14
Chord Length, ft.	.50	.50	.50	.30
Airfoil Section	NACA 6421 (Mod.)	NACA 0018	Lemniscate (Mod.)	NACA 6421 (Mod.)
Propeller Position, in.	5.13*	5.13*	2.59; 4.08; 5.13*	3.08*
Propeller Tip Clearance, in.	.040	.037 Fore Prop. .076 Aft Prop.	.046; .088	.039

*Normal location of rear propeller reference line (see Table 6) from duct leading edge.

EXIT VANE	
Number of vanes	2
Chord, ft.	.20
Span, ft.	1.29
Total Area, sq. ft.	.52
Airfoil Section	Symmetrical 15% Thickness Ratio

TABLE 5 (cont.)

PHYSICAL CHARACTERISTICS OF MODEL

CENTERBODY

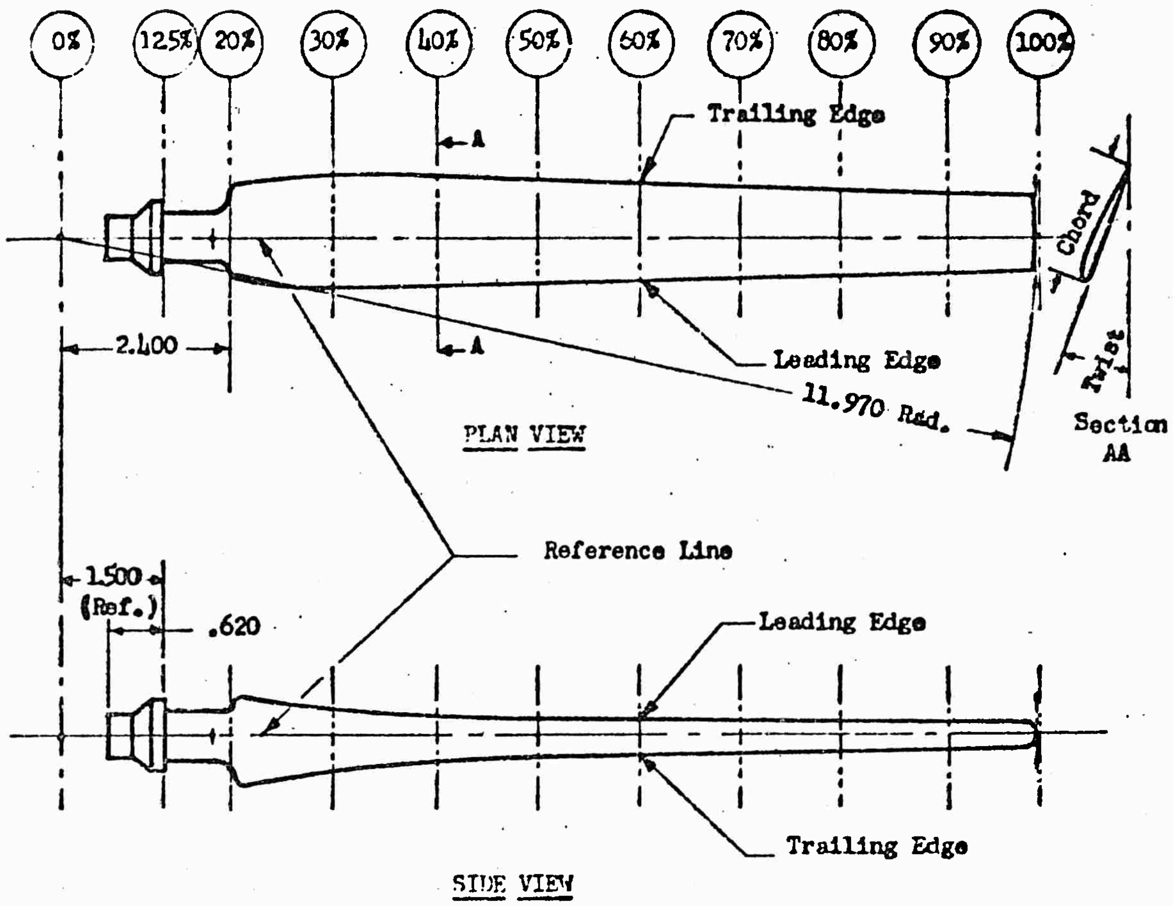
Diameter, ft.	
Electric Motor Housing and Dummy	.43
Transmission	.40
Hubs and Spinner	.33
Total Length for Basic Model, ft.	2.83
Total Length with Dummy of Electric Motor Housing, ft.	4.66
Dummy Engines	(See Figure 3C)

PROPELLERS (Contra-Rotating)

No. of Blades/Propeller	2 Twisted	3 Twisted	3 Untwisted
Section	RAF-6	RAF-6	RAF-6
t/c at .7R	.12	.12	.12
$c_{.7R}$, in.	1.11	1.11	1.46
Taper ($c_{1.0R}$ to $c_{.2R}$)	.55	.55	.55
Maximum Radius, ft.	.998	.998	.998
Solidity	.118	.177	.232
Blade Pitch Angle, deg.	Variable	Variable	Variable
Distance between Propeller Planes, in.	1.50	1.50	1.50

TABLE 6

PROPELLER BLADE CHARACTERISTICS



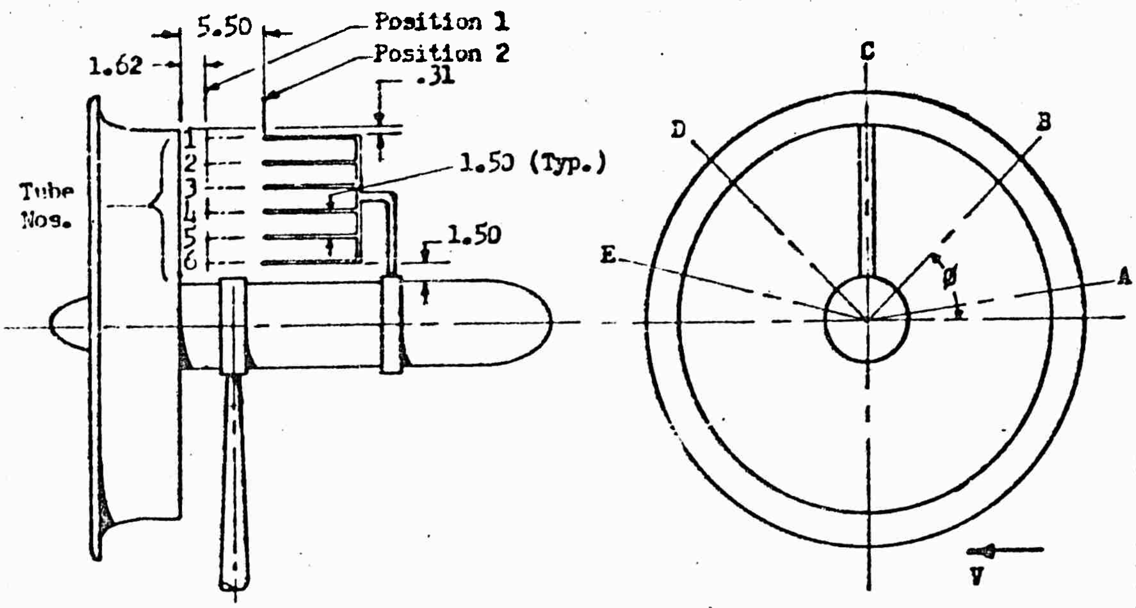
Blade sections from 20% station to 100% station inclusive are RAF-6 airfoils of 12% thickness ratio.

Blade Station, %R	20	30	40	50	60	70	80	90	100
Blade Chord, in.	1.54	1.46	1.37	1.29	1.20	1.11	1.03	.94	.86
Blade Twist, deg.	42.50	28.30	21.20	17.00	14.18	12.13	10.61	9.45	8.50

Untwisted, constant chord blade fabricated using the blade chord and twist at the 30 percent radius station of the twisted blade.

TABLE 7

YAWMETER RAKE ORIENTATION



SCHEDULE OF AZIMUTH ANGLE, Ø

	β = 12°		β = 18°	
	POSITION		POSITION	
	1	2	1	2
A*	8° 29'	8° 29'	8° 26'	8° 16'
B	45° 00'	45° 10'		
C	89° 45'	90° 58'	89° 40'	89° 40'
D	135° 13'	134° 45'		
E*	166° 34'	166° 43'	166° 34'	166° 46'

*These Ø's were restricted from the duct horizontal plane of symmetry by the duct support system (not shown for clarity).

TABLE 8

EXIT VELOCITY SURVEY DATA
Part a

PART a: Distance behind duct exit = 5.50 inches; β = 12 degrees

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3000	10	166 43	204	1	02476	07359	01933	01549	07356	07354
3000	10	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	10	166 43	204	3	04192	06733	03556	02224	06727	06719
3000	10	166 43	204	4	04790	06162	03460	03320	06151	06150
3000	10	166 43	204	5	04616	05487	00018-	04616	05469	05487
3000	00	166 43	204	1	01586	07232	01105	01137	07230	07230
3000	00	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	00	166 43	204	3	04205	06691	03226	02703	06683	06680
3000	00	166 43	204	4	04706	06162	02960	03665	06149	06153
3000	00	166 43	204	5	04997	05571	00446-	04977	05549	05570
3000	10	166 43	204	1	01145	07197	01105	00300	07196	07195
3000	10	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	10	166 43	204	3	03894	06507	02731	02780	06599	06599
3000	10	166 43	204	4	05015	05951	02859	04127	05935	05943
3000	10	166 43	204	5	05535	05529	00570-	05506	05503	05528
3000	20	166 43	204	1	00880	07112	00380	00007	07111	07111
3000	20	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	20	166 43	204	3	04238	06523	02771	03211	06512	06515
3000	20	166 43	204	4	05111	06078	02690	04352	06060	06071
3000	20	166 43	204	5	05871	05529	00335-	05312	05500	05528
3000	30	166 43	204	1	01181	06943	01065	00510-	06942	06941
3000	30	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	30	166 43	204	3	04353	06312	02726	03999	06300	06306
3000	30	166 43	204	4	05277	05915	02588	04548	05396	05208
3000	30	166 43	204	5	06076	05535	00784-	06026	05504	05534
3000	40	166 43	204	1	01580	06725	01189	01040-	06723	06723
3000	40	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	40	166 43	204	3	04650	06228	02737	03765	06214	06220
3000	40	166 43	204	4	05300	05704	02931	04424	05687	05696
3000	40	166 43	204	5	06357	05366	00972-	06283	05333	05365
3000	50	166 43	204	1	01849	06429	01183	01421-	06426	06427
3000	50	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	50	166 43	204	3	04270	06186	02494	03470	06174	06180
3000	50	166 43	204	4	05571	05704	02545	04962	05582	05598
3000	50	166 43	204	5	06267	05324	00555-	06242	05292	05323

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.
2. Negative values in the table are followed by a negative sign.

TABLE 8

PART a (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3000	60	166 43	204	1	01208	06350	00381	01146-	06348	06349
3000	60	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	60	166 43	204	3	04172	06312	02255	03514	06300	06307
3000	60	166 43	204	4	05417	05662	02514	04805	05642	05656
3000	60	166 43	204	5	06461	05366	00598-	06434	05332	05365
3000	70	166 43	204	1	01291	06350	00361	01240-	06348	06349
3000	70	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	70	166 43	204	3	04209	06060	01992	03711	06047	06056
3000	70	166 43	204	4	04871	05656	02269	04314	05639	05651
3000	70	166 43	204	5	05617	05360	01161-	05497	05335	05358
3000	80	166 43	204	1	00418	06024	00304-	00287	06023	06023
3000	80	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	80	166 43	204	3	03652	05891	01406	03587	05879	05889
3000	80	166 43	204	4	05001	05487	01946	04610	05469	05483
3000	80	166 43	204	5	05903	05276	01304-	05759	05269	05274
3000	90	166 43	204	1	01724	05667	00946-	01441	05665	05666
3000	90	166 43	204	2	99999	99999	99999	99999	99999	99999
3000	90	166 43	204	3	03575	05934	00838	03475	05923	05933
3000	90	166 43	204	4	04361	05614	01046	04234	05598	05613
3000	90	166 43	204	5	05550	05487	01303-	05396	05462	05485
3010	10	166 43	410	1	21851	08354	21160	05980-	08314	07796
3010	10	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	10	166 43	410	3	20762	06248	20756	00349	06247	05842
3010	10	166 43	410	4	18417	04726	18372	01371-	04724	04485
3010	10	166 43	410	5	27508	01341	19906	24614	01229	01308
3010	00	166 43	410	1	18024	08718	17687	03702-	08701	08307
3010	00	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	00	166 43	410	3	18158	06499	18158	00000	06498	06173
3010	00	166 43	410	4	16746	05132	16693	01469-	05130	04919
3010	00	166 43	410	5	25236	01313	08301	24141	01200	01201
3010	10	166 43	410	1	12997	09118	12717	02773-	09107	08094
3010	10	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	10	166 43	410	3	14668	06826	14494	02210	06821	06609
3010	10	166 43	410	4	13821	05604	13679	02054	05600	05449
3010	10	166 43	410	5	11195	03131	03442	10678	03076	03129
3010	20	166 43	410	1	10279	09322	10171	01517-	09218	09173
3010	20	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	20	166 43	410	3	12331	07080	12065	02625	07072	06923
3010	20	166 43	410	4	11360	06075	10773	03692	06062	05968
3010	20	166 43	410	5	07808	04772	02717	07331	04733	04766
3010	30	166 43	410	1	08518	09228	08505	00486-	09227	09126
3010	30	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	30	166 43	410	3	10178	07234	09832	02685	07226	07127
3010	30	166 43	410	4	10078	06317	09098	04408	06298	06237
3010	30	166 43	410	5	06804	05321	02493	06339	05288	05316
3010	40	166 43	410	1	07886	08930	07870	00515	08929	08845

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART a (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3010	40	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	40	166 43	410	3	08533	07192	08101	02716	07184	07120
3010	40	166 43	410	4	08726	06347	07585	04365	06328	06291
3010	40	166 43	410	5	06277	05616	02234	05871	05586	05611
3010	50	166 43	410	1	07700	08590	07696	00250	08589	08512
3010	50	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	50	166 43	410	3	08211	06183	06144	05489	06154	06147
3010	50	166 43	410	4	08280	06178	06859	04681	06157	06134
3010	50	166 43	410	5	06087	05743	01919	05781	05713	05739
3010	60	166 43	410	1	05411	08021	06318	01098-	08019	07972
3010	60	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	60	166 43	410	3	07680	06730	06663	03854	06714	06684
3010	60	166 43	410	4	08218	06220	06222	05411	06192	06183
3010	60	166 43	410	5	05778	05701	01862	06522	05664	05698
3010	70	166 43	410	1	05361	07928	05342	00461-	07927	07893
3010	70	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	70	166 43	410	3	07089	06603	06028	03759	06588	06566
3010	70	166 43	410	4	07562	06172	05587	05129	06147	06142
3010	70	166 43	410	5	06546	05743	02230	06160	05709	05738
3010	80	166 43	410	1	03992	07489	03992	00049-	07489	07470
3010	80	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	80	166 43	410	3	06302	06477	05165	03631	06464	06450
3010	80	166 43	410	4	06623	06172	04892	04487	06153	06149
3010	80	166 43	410	5	06026	05785	01618	05808	05755	05782
3010	90	166 43	410	1	03203	07017	02880	01404	07014	07008
3010	90	166 43	410	2	99999	99999	99999	99999	99999	99999
3010	90	165 43	410	3	04618	06393	03468	03056	06383	06381
3010	90	166 43	410	4	05765	06039	03481	04607	06019	06027
3010	90	166 43	410	5	05693	05611	01067	05593	05584	05610
3020	10	166 43	616	1	99999	99999	99999	99999	99999	99999
3020	10	166 43	616	2	99999	99999	99999	99999	99999	99999
3020	10	166 43	616	3	99999	99999	99999	99999	99999	99999
3020	10	166 43	616	4	99999	99999	99999	99999	99999	99999
3020	10	166 43	616	5	29097	01349	19383	23325	01249	01283
3020	00	166 43	617	1	99999	99999	99999	99999	99999	99999
3020	00	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	00	166 43	617	3	99999	99999	99999	99999	99999	99999
3020	00	166 43	617	4	24286	04811	24286	00181	04810	04385
3020	00	166 43	617	5	99999	99999	99999	99999	99999	99999
3020	10	166 43	617	1	28827	10920	27171	11229-	10753	09753
3020	10	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	10	166 43	617	3	25610	06752	25592	01098	06750	06089
3020	10	166 43	617	4	21506	05682	21178	04096	05469	05113
3020	10	166 43	617	5	13701	03101	05314	12700	03025	03088
3020	20	166 43	617	1	22538	10502	21751	06510-	10443	09762
3020	20	166 43	617	2	99999	99999	99999	99999	99999	99999

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART a (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3020	20	166 43	617	3	20182	07128	20112	01828	07124	06693
3020	20	166 43	617	4	18880	05949	18242	05212	05926	05652
3020	20	166 43	617	5	11750	04657	04598	10859	04574	04642
3020	30	166 43	617	1	17040	10817	16920	02133-	10810	10349
3020	30	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	30	166 43	617	3	13403	07871	15308	01791	07867	07591
3020	30	166 43	617	4	15013	06451	14439	04292	06433	06248
3020	30	166 43	617	5	10305	05667	04773	09174	05594	05647
3020	40	166 43	617	1	12371	10775	12358	00577	10774	10525
3020	40	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	40	166 43	617	3	11608	08122	11475	01797	08118	07959
3020	40	166 43	617	4	12132	06594	11487	04010	06578	06462
3020	40	166 43	617	5	09086	06126	04987	07633	06072	06103
3020	50	166 43	617	1	11596	09625	11291	02708-	09614	09459
3020	50	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	50	166 43	617	3	11249	07743	10798	03227	07731	07606
3020	50	166 43	617	4	11043	06787	09892	05007	06761	06686
3020	50	166 43	617	5	07450	06373	04537	05936	06338	06359
3020	60	166 43	617	1	10336	09828	10172	01871-	09822	09673
3020	60	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	60	166 43	617	3	10999	07827	10434	03555	07812	07698
3020	60	166 43	617	4	11757	06715	10360	05664	06683	06606
3020	60	166 43	617	5	07490	06415	04947	05977	06380	06394
3020	70	166 43	617	1	08396	09776	08339	00992-	09774	09672
3020	70	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	70	166 43	617	3	10289	07525	09748	03356	07512	07416
3020	70	166 43	617	4	10825	06660	09494	05297	06632	06569
3020	70	166 43	617	5	07511	06247	04737	05855	06214	06229
3020	80	166 43	617	1	06879	09256	06874	00287-	09255	09189
3020	80	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	80	166 43	617	3	06593	07357	08064	03006	07347	07284
3020	80	166 43	617	4	10061	06399	08645	05226	06372	06328
3020	80	166 43	617	5	06420	06289	03951	05075	06264	06274
3020	90	166 43	617	1	05062	07959	04248	02762	07949	07937
3020	90	166 43	617	2	99999	99999	99999	99999	99999	99999
3020	90	166 43	617	3	05220	07020	04648	02386	07013	06996
3020	90	166 43	617	4	06733	06464	05437	03995	06448	06435
3020	90	166 43	617	5	05500	06198	02528	04891	06175	06191
3030	00	166 43	000	1	01739	04943	01452	00957	04942	04941
3030	00	166 43	000	2	99999	99999	99999	99999	99999	99999
3030	00	166 43	000	3	03789	05675	00831	03697	05663	05674
3030	00	166 43	000	4	03973	05566	00830	03886	05553	05565
3030	00	166 43	000	5	05336	05566	01517-	05116	05543	05563
3040	00	134 45	205	1	08872	08296	07160	05294-	08261	08291
3040	00	134 45	205	2	99999	99999	99999	99999	99999	99999
3040	00	134 45	205	3	10652	06474	10353	02559-	06467	06368

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 5

PART a (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3040	00	134 45	205	4	11760	05653	11721	00993-	05652	05535
3040	00	134 45	205	5	11112	05413	10671	03170	05405	05319
3040	20	134 45	205	1	07446	05110	05962	04493-	08085	08066
3040	20	134 45	205	2	99999	99999	99999	99999	99999	99999
3040	20	134 45	205	3	09580	06432	09520	01083-	06430	06343
3040	20	134 45	205	4	10226	05805	10223	00235	05804	05712
3040	20	134 45	205	5	10281	05455	09536	03912	05442	05379
3040	40	134 45	205	1	06078	07296	04702	03868-	07279	07271
3040	40	134 45	205	2	99999	99999	99999	99999	99999	99999
3040	40	1[illegible] 45	205	3	08215	06138	08214	00077	06138	06075
3040	40	134 45	205	4	08785	05625	08728	01016	05624	05559
3040	40	134 45	205	5	08953	05492	07993	04085	05478	05438
3040	60	134 45	205	1	03434	06464	02657	02178-	06459	06456
3040	60	134 45	205	2	99999	99999	99999	99999	99999	99999
3040	60	134 45	205	3	05571	05969	05545	00539	05968	05941
3040	60	134 45	205	4	06305	05402	06210	01095	05401	05370
3040	60	134 45	205	5	06643	05360	05735	03374	05350	05333
3040	80	134 45	205	1	02578	05915	02449	00806-	05914	05909
3040	80	134 45	205	2	99999	99999	99999	99999	99999	99999
3040	80	134 45	205	3	03673	05675	03614	00658	05674	05663
3040	80	134 45	205	4	04176	05397	04120	00680	05396	05383
3040	80	134 45	205	5	04329	05313	03411	02672	05307	05303
3050	00	134 45	410	1	99999	99999	99999	99999	99999	99999
3050	00	134 45	410	2	99999	99999	99999	99999	99999	99999
3050	00	134 45	410	3	99999	99999	99999	99999	99999	99999
3050	00	134 45	410	4	34309	05559	34062	05278-	05841	04860
3050	00	134 45	410	5	99999	99999	99999	99999	99999	99999
3050	20	134 45	418	1	29097	29335	15988	25506-	08485	09037
3050	20	134 45	418	2	99999	99999	99999	99999	99999	99999
3050	20	134 45	418	3	24926	06253	24394	05803-	06226	05699
3050	20	134 45	418	4	24012	06082	23993	01089-	06081	05556
3050	20	134 45	418	5	99999	99999	99999	99999	99999	99999
3050	40	134 45	418	1	16256	08688	08054	14303-	08423	08607
3050	40	134 45	418	2	99999	99999	99999	99999	99999	99999
3050	40	134 45	418	3	16733	06297	16504	02920-	06289	06038
3050	40	134 45	418	4	17735	05920	17735	00041	05919	05638
3050	40	134 45	418	5	17354	04879	16527	05615	04857	04679
3050	60	134 45	418	1	09392	07998	02437	09083-	07897	07990
3050	60	134 45	418	2	99999	99999	99999	99999	99999	99999
3050	60	134 45	418	3	11027	06396	11026	00128	06395	06277
3050	60	134 45	418	4	12072	06078	11927	01554	06075	05946
3050	60	134 45	418	5	12161	05588	11276	04675	05570	05480
3050	80	134 45	418	1	07563	07261	02524	07138-	07204	07254
3050	80	134 45	418	2	99999	99999	99999	99999	99999	99999
3050	80	134 45	418	3	07713	06348	07708	00275	06347	06290
3050	80	134 45	418	4	08155	05836	08027	01459	05834	05778

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART a (continued)

Code No.	α deg	φ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3050	80	134 45	418	5	08319	05535	07464	03715	05523	05488
3060	00	134 45	613	1	99999	99999	99099	99999	99999	99999
3060	00	134 45	613	2	99999	99999	99999	99999	99999	99999
3060	00	134 45	613	3	99999	99999	99999	99999	99999	99999
3060	00	134 45	613	4	99999	99999	99999	99999	99999	99999
3060	00	134 45	613	5	99999	99999	99999	99999	99999	99999
3060	10	134 45	614	1	99999	99999	99999	99999	99999	99999
3060	10	134 45	614	2	99999	99999	99999	99999	99999	99999
3060	10	134 45	614	3	99999	99999	99999	99999	99999	99999
3060	10	134 45	614	4	99999	99999	99999	99999	99999	99999
3060	10	134 45	614	5	99999	99999	99999	99999	99999	99999
3060	20	134 45	614	1	99999	99999	99999	99999	99999	99999
3060	20	134 45	614	2	99999	99999	99999	99999	99999	99999
3060	20	134 45	614	3	99999	99999	99999	99999	99999	99999
3060	20	134 45	614	4	99999	99999	99999	99999	99999	99999
3060	20	134 45	614	5	99999	99999	99999	99999	99999	99999
3060	30	134 45	616	1	99999	99999	99999	99999	99999	99999
3060	30	134 45	616	2	99999	99999	99999	99999	99999	99999
3060	30	134 45	616	3	30506	07486	30471	01786-	07483	06452
3060	30	134 45	616	4	99999	99999	99999	99999	99999	99999
3060	30	134 45	616	5	30642	10323	12863	28661-	09110	10121
3060	40	134 45	616	1	99999	99999	99999	99999	99999	99999
3060	40	134 45	616	2	25997	07501	25712	04408-	07482	06761
3060	40	134 45	616	3	25282	07112	25281	00233-	07111	06430
3060	40	134 45	616	4	26439	04810	25762	06833	04782	04337
3060	40	134 45	616	5	21706	09533	08166	20370-	08947	09447
3060	50	134 45	616	1	99999	99999	99999	99999	99999	99999
3060	50	134 45	616	2	19848	07281	19740	02244-	07275	06853
3060	50	134 45	616	3	21060	06813	21040	00998	06812	06358
3060	50	134 45	616	4	19870	05487	19081	05974	05460	05188
3060	50	134 45	616	5	17886	09011	03364	17606-	08590	08996
3060	60	134 45	616	1	34823	07498	34644	04588	07481	06174
3060	60	134 45	616	2	16435	07229	16428	00508-	07228	06933
3060	60	134 45	616	3	17475	06700	17408	01635	06697	06393
3060	60	134 45	616	4	15929	06123	15183	05050	06100	05910
3060	60	134 45	616	5	16727	08152	07473	15130-	07873	08087
3060	70	134 45	616	1	99999	99999	99999	99999	99999	99999
3060	70	134 45	616	2	13014	06926	12997	00684-	06925	06748
3060	70	134 45	616	3	12969	06483	12857	01758	06480	06320
3060	70	134 45	616	4	12302	06190	11592	04232	06173	06064
3060	70	134 45	616	5	14149	08104	06923	12459-	07915	08047
3060	80	134 45	616	1	99999	99999	99999	99999	99999	99999
3060	80	134 45	616	2	11207	06989	11161	01034-	06987	06856
3060	80	134 45	616	3	11483	06372	11464	00678	06371	06244
3060	80	134 45	616	4	11082	05966	10450	03772	05953	05867
3060	80	134 45	616	5						

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART a (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3060	90	134 45	616	1	08831	07194	06589	05931-	07156	07146
3060	90	134 45	616	2	99999	99999	99999	99999	99999	99999
3060	90	134 45	616	3	05937	05603	05747	01498-	06600	06569
3060	90	134 45	616	4	06021	05996	06021	00046-	05976	05962
3060	90	134 45	616	5	05005	06033	04674	01796	06029	06012
3070	00	134 45	000	1	04582	04617	04559	00452-	04616	04602
3070	00	134 45	000	2	99999	99999	99999	99999	99999	99999
3070	00	134 45	000	3	01748	05299	01677	00492	05298	05296
3070	00	134 45	000	4	02083	05184	01951	00732	05183	05180
3070	00	134 45	000	5	02626	05226	00892	02470	05221	05225
3080	00	090 58	205	1	99999	99999	99999	99999	99999	99999
3080	00	090 58	205	2	27350	05981	19113	21007-	05622	05690
3080	00	090 58	205	3	21113	05296	17243	12938-	05172	05069
3080	00	090 58	205	4	20459	05532	17840	10684-	05444	05274
3080	00	090 58	205	5	19500	05422	17878	08313-	05370	05165
3080	20	090 58	206	1	15100	05812	12894-	08129-	05756	05668
3080	20	090 58	206	2	13062	06591	12403	04225-	06573	06437
3080	20	090 58	206	3	12632	06075	12046	03914-	06061	05941
3080	20	090 58	206	4	13770	05945	13102	04389-	05929	05792
3080	20	090 58	206	5	14313	05800	14317	03963-	05786	05620
3080	40	090 58	207	1	09496	05661	08008-	05170-	05638	05606
3080	40	090 58	207	2	09205	06444	08969	02103-	06439	06365
3080	40	090 58	207	3	09585	06099	09274	02464-	06093	06019
3080	40	090 58	207	4	11524	05692	11195	02807-	05685	05583
3080	40	090 58	207	5	11320	05881	11129	02125-	05877	05770
3080	60	090 58	207	1	07299	05395	06072-	04080-	05381	05364
3080	60	090 58	207	2	06719	06529	06645	01000-	06527	06485
3080	60	090 58	207	3	07413	06141	07331	01109-	06139	06090
3080	60	090 58	207	4	08985	05676	08832	01676-	05673	05608
3080	60	090 58	207	5	09187	05749	09107	01229-	05747	05676
3080	80	090 58	207	1	02667	04861	01347-	02303-	04857	04859
3080	80	090 58	207	2	03803	06311	03765	00539	06310	06297
3080	80	090 58	207	3	03946	05973	03945	00052	05972	05958
3080	80	090 58	207	4	04875	05569	04847	00521-	05568	05549
3080	80	090 58	207	5	05513	05569	05507	00258	05568	05543
3090	00	090 58	411	1	99999	99999	99999	99999	99999	99999
3090	00	090 58	411	2	99999	99999	99999	99999	99999	99999
3090	00	090 58	411	3	99999	99999	99999	99999	99999	99999
3090	00	090 58	411	4	99999	99999	99999	99999	99599	99999
3090	00	090 58	411	5	99999	99999	99999	99999	99999	99999
3090	20	090 58	411	1	99399	99999	99999	99999	99999	99999
3090	20	090 58	411	2	99999	99999	99999	99999	99999	99999
3090	20	090 58	411	3	99999	99999	99999	99999	99999	99999
3090	20	090 58	411	4	99999	99999	99999	99999	99999	99999
3090	20	090 58	411	5	99999	99999	99999	99999	99999	99999
3090	40	090 58	411	1	21447	06970	18123-	12257-	06825	06638

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART a (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_α $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3090	40	090 58	411	2	21771	07136	20740	07238-	07086	06680
3090	40	090 58	411	3	20922	06710	20111	06273-	06674	06305
3090	40	090 58	411	4	22357	06493	21620	06271-	06459	06041
3090	40	090 58	411	5	23095	06179	22738	04504-	06162	05701
3090	60	090 58	411	1	14369	06607	13051-	06223-	06570	06438
3090	60	090 58	411	2	13925	06942	13674	02990-	06933	06747
3090	60	090 58	411	3	13838	06555	13580	02760-	06547	06372
3090	60	090 58	411	4	15221	06371	14960	02939-	06363	06155
3090	60	090 58	411	5	16338	05966	16200	02242-	05961	05729
3090	80	090 58	411	1	07763	05185	07462-	02164-	05181	05141
3090	80	090 58	411	2	07552	06865	07457	01207	06863	06806
3090	80	090 58	411	3	08004	06474	07988	00506	06473	06411
3090	80	090 58	411	4	09027	06265	09026	00091-	06265	06187
3090	80	090 58	411	5	09552	05915	09557	00020-	05914	05832
3100	00	090 58	619	1	99999	99999	99999.	99999	99999	99999
3100	00	090 58	619	2	99999	99999	99999	99999	99999	99999
3100	00	090 58	619	3	99999	99999	99999	99999	99999	99999
3100	00	090 58	619	4	99999	99999	99999	99999	99999	99999
3100	00	090 58	619	5	99999	99999	99999	99999	99999	99999
3100	10	090 58	619	1	99999	99999	99999	99999	99999	99999
3100	10	090 58	619	2	99999	99999	99999	99999	99999	99999
3100	10	090 58	619	3	99999	99999	99999	99999	99999	99999
3100	10	090 58	619	4	99999	99999	99999	99999	99999	99999
3100	10	090 58	619	5	99999	99999	99999	99999	99999	99999
3100	20	090 58	619	1	99999	99999	99999	99999	99999	99999
3100	20	090 58	619	2	99999	99999	99999	99999	99999	99999
3100	20	090 58	619	3	99999	99999	99999	99999	99999	99999
3100	20	090 58	619	4	99999	99999	99999	99999	99999	99999
3100	20	090 58	619	5	99999	99999	99999	99999	99999	99999
3100	30	090 58	619	1	99999	99999	99999	99999	99999	99999
3100	30	090 58	619	2	99999	99999	99999-	99999	99999	99999
3100	30	090 58	619	3	99999	99999	99999	99999	99999	99999
3100	30	090 58	619	4	99999	99999	99999	99999	99999	99999
3100	30	090 58	619	5	99999	99999	99999	99999	99999	99999
3100	40	090 58	619	1	99999	99999	99999	99999	99999	99999
3100	40	090 58	619	2	99999	99999	99999	99999	99999	99999
3100	40	090 58	619	3	99999	99999	99999	99999	99999	99999
3100	40	090 58	619	4	99999	99999	99999	99999	99999	99999
3100	40	090 58	619	5	99999	99999	99999	99999	99999	99999
3100	50	090 58	619	1	27507	07587	25429-	11989-	07451	06879
3100	50	090 58	619	2	29558	08038	28901	07393-	07986	07050
3100	50	090 58	619	3	26742	07287	26070	06873-	07244	06554
3100	50	090 58	619	4	99999	99999	99999	99999	99999	99999
3100	50	090 58	619	5	99999	99999	99999	99999	99999	99999
3100	60	090 58	620	1	18917	07152	18367-	04856-	07128	06790
3100	60	090 58	620	2	15822	07890	15746	01632-	07887	07594

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 6

PART a (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3100	60	090 58	620	3	15524	07488	15377	02242-	07482	07220
3100	60	090 58	620	4	17453	06959	17251	02813-	06951	06646
3100	60	090 58	620	5	18753	06508	18692	01613-	06505	06164
3100	70	090 58	620	1	17728	06242	17569-	02520-	06236	05951
3100	70	090 58	620	2	13041	07820	13029	00575	07819	07618
3100	70	090 58	620	3	13174	07428	13171	00252-	07427	07232
3100	70	090 58	620	4	14353	07032	14302	01270-	07030	06814
3100	70	090 58	620	5	14991	06607	14981	00589-	06606	06382
3100	80	090 58	620	1	11392	06090	10956-	03200-	06080	05979
3100	80	090 58	620	2	10567	07246	10566	00121-	07245	07123
3100	80	090 58	620	3	10635	06726	10604	00830-	06725	06611
3100	80	090 58	620	4	10764	06617	10677	01397-	06615	06502
3100	80	090 58	620	5	11146	06386	11130	00609-	06385	06265
3100	90	090 58	620	1	06422	05896	05405-	03489-	05885	05869
3100	90	090 58	620	2	06838	06907	06805	00677-	06906	06858
3100	90	090 58	620	3	07005	06558	06876	01349-	06556	06510
3100	90	090 58	620	4	07570	06168	07261	02161-	06163	06118
3100	90	090 58	62	5	07451	06036	07385	00998-	06035	05985
3110	00	090 58	000	1	06006	03771	04380	04125-	03761	03759
3110	00	090 58	000	2	01212	06090	01177	00288	06089	06088
3110	00	090 58	000	3	02388	05549	02388	00055-	05548	05544
3110	00	090 58	000	4	02388	05476	02264	00761-	05475	05471
3110	00	090 58	000	5	02704	05265	02701	00128	05264	05259
3120	00	045 10	206	1	99999	99999	99999	99999	99999	99999
3120	00	045 10	206	2	99999	99999	99999	99999	99999	99999
3120	00	045 10	206	3	16732	04626	15350	06987-	04594	04463
3120	00	045 10	206	4	16777	04743	14408	08967-	04688	04597
3120	00	045 10	206	5	16112	05440	13741	08741-	05380	05287
3120	20	045 10	206	1	99999	99999	99999	99999	99999	99999
3120	20	045 10	206	2	15774	03945	11624	10956-	03875	03866
3120	20	045 10	206	3	14071	05244	12029	07618-	05200	05130
3120	20	045 10	206	4	13919	05349	11657	07818-	05301	05240
3120	20	045 10	206	5	13639	05732	11560	07436-	05685	05617
3120	40	045 10	206	1	99999	99999	99999	99999	99999	99999
3120	40	045 10	206	2	11034	06060	09838	05094-	06036	05971
3120	40	045 10	206	3	10257	06222	09442	04080-	06206	06138
3120	40	045 10	206	4	10177	06144	09019	04793-	06123	06068
3120	40	045 10	206	5	11060	06174	09705	05407-	06147	06086
3120	60	045 10	207	1	09410	00212	06668-	06699	00210	00210
3120	60	045 10	207	2	07243	06356	07042	01714-	06353	06308
3120	60	045 10	207	3	07046	06222	06368	03040-	06213	06183
3120	60	045 10	207	4	06445	06120	05465	03437-	06109	06092
3120	60	045 10	207	5	06657	06036	06044	02812-	06028	06002
3120	80	045 10	207	1	06472	01527	03914-	05170	01520	01523
3120	80	045 10	207	2	04877	06096	04734	01178-	06094	06075
3120	80	045 10	207	3	04984	05885	04274	02573-	05879	05868

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART a (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft²	i_α deg	i_β deg	q_σ lb/ft²	q_β lb/ft²
3120	80	045 10	207	4	04948	05776	03740	03248-	05766	05763
3120	80	045 10	207	5	04589	05608	04105	02058-	05604	05593
3130	00	045 01	411	1	99999	99999	99999	99999	99999	99999
3130	00	045 01	411	2	99999	99999	99999	99999	99999	99999
3130	00	045 01	411	3	99999	99999	99999	99999	99999	99999
3130	00	045 01	411	4	99999	99999	99999	99999	99999	99999
3130	00	045 01	411	5	29480	03548	28098	10524-	03501	03141
3130	20	045 01	413	1	99999	99999	99999	99999	99999	99999
3130	20	045 01	413	2	99999	99999	99999	99999	99999	99999
3130	20	045 01	413	3	99999	99999	99999	99999	99999	99999
3130	20	045 01	413	4	99999	99999	99999	99999	99999	99999
3130	20	045 01	413	5	99999	99999	99999	99999	99999	99999
3130	40	045 01	413	1	99999	99999	99999	99999	99999	99999
3130	40	045 01	413	2	24629	04263	22437	11265-	04192	03951
3130	40	045 01	413	3	20370	05461	19097	07638-	05417	05165
3130	40	045 01	413	4	23181	05934	21433	09707-	05860	05534
3130	40	045 01	413	5	21535	06424	19822	09123-	06351	06052
3130	60	045 01	413	1	99999	99999	99999	99999	99999	99999
3130	60	045 01	413	2	13051	06758	12325	04428-	06738	06603
3130	60	045 01	413	3	12031	06655	11137	04668-	06633	06530
3130	60	045 01	413	4	12714	06345	11521	05524-	06316	06218
3130	60	045 01	413	5	12416	06695	11435	04966-	06670	06563
3130	80	045 01	412	1	07709	02762	03166-	07043	02741	02757
3130	80	045 01	412	2	03904	07070	03842	00696-	07069	07054
3130	80	045 01	412	3	04172	06726	03696	01940-	06722	06711
3130	80	045 01	412	4	04355	06240	03383	02748-	06232	06229
3130	80	045 01	412	5	04755	06156	04384	01849-	06152	06138
3140	00	045 01	619	1	99999	99999	99999	99999	99999	99999
3140	00	045 01	619	2	99999	99999	99999	99999	99999	99999
3140	00	045 01	619	3	99999	99999	99999	99999	99999	99999
3140	00	045 01	619	4	99999	99999	99999	99999	99999	99999
3140	00	045 01	619	5	99999	99999	99999	99999	99999	99999
3140	10	045 01	619	1	99999	99999	99999	99999	99999	99999
3140	10	045 01	619	2	99999	99999	99999	99999	99999	99999
3140	10	045 01	619	3	99999	99999	99999	99999	99999	99999
3140	10	045 01	619	4	99999	99999	99999	99999	99999	99999
3140	10	045 01	619	5	99999	99999	99999	99999	99999	99999
3140	20	045 01	619	1	99999	99999	99999	99999	99999	99999
3140	20	045 01	619	2	99999	99999	99999	99999	99999	99999
3140	20	045 01	619	3	99999	99999	99999	99999	99999	99999
3140	20	045 01	619	4	99999	99999	99999	99999	99999	99999
3140	20	045 01	619	5	99999	99999	99999	99999	99999	99999
3140	30	045 01	619	1	99999	99999	99999	99999	99999	99999
3140	30	045 01	619	2	99999	99999	99999	99999	99999	99999
3140	30	045 01	619	3	99999	99999	99999	99999	99999	99999
3140	30	045 01	619	4	99999	99999	99999	99999	99999	99999

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART a (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3140	30	045 01	619	5	99999	99999	99999	99999	99999	99999
3140	40	045 01	621	1	99999	99999	99999	99999	99999	99999
3140	40	045 01	621	2	31629	05851	30512	10142-	05782	05061
3140	40	045 01	621	3	26830	06952	25869	08186-	06894	06267
3140	40	045 01	621	4	28356	06880	26639	11264-	06773	06173
3140	40	045 01	621	5	25193	07625	23503	10167-	07523	07009
3140	50	045 01	621	1	99999	99999	99999	99999	99999	99999
3140	50	045 01	621	2	25312	06598	24290	08051-	06543	06023
3140	50	045 01	621	3	22308	06855	21283	07344-	06806	06394
3140	50	045 01	621	4	22886	06699	21225	09390-	06620	06255
3140	50	045 01	621	5	21665	07252	20062	08884-	07175	06821
3140	60	045 01	621	1	99999	99999	99999	99999	99999	99999
3140	60	045 01	621	2	16900	07340	16158	05224-	07311	07052
3140	60	045 01	621	3	15962	06998	15046	05581-	06966	06760
3140	60	045 01	621	4	16394	06725	14835	07296-	06674	06504
3140	60	045 01	621	5	16192	07204	14824	06813-	07156	06967
3140	70	045 01	621	1	21141	03671	09830-	19070	03474	03622
3140	70	045 01	621	2	11877	07720	11568	02769-	07711	07563
3140	70	045 01	621	3	10750	07280	10198	03473-	07267	07165
3140	70	045 01	621	4	11624	06800	10539	05017-	06774	06686
3140	70	045 01	621	5	11422	07274	10437	04745-	07249	07154
3140	80	045 01	621	1	12292	04003	03092-	11919	03916	03997
3140	80	045 01	621	2	08121	07967	08059	01016-	07965	07888
3140	80	045 01	621	3	07881	07609	07450	02599-	07601	07544
3140	80	045 01	621	4	07858	07098	07048	03508-	07084	07044
3140	80	045 01	621	5	08165	07098	07447	03387-	07085	07038
3150	00	045 01	000	1	06897	02038	03388-	06021-	02026	02034
3150	00	045 01	000	2	01837	05329	00941	01578-	05326	05328
3150	00	045 01	000	3	02526	04960	01315	02157-	04956	04958
3150	00	045 01	000	4	02357	04970	00382	02326-	04965	04969
3150	00	045 01	000	5	01042	04760	00480	00925-	04759	04759
3160	00	008 29	203	1	99999	99999	99999	99999	99999	99999
3160	00	008 29	203	2	13236	00212	10315	08474	00209	00208
3160	00	008 29	203	3	09706	03615	08977	03751	03607	03570
3160	00	008 29	203	4	10561	04454	10464	01459	04452	04379
3160	00	008 29	203	5	09996	04901	09532	03066	04894	04833
3160	20	008 29	203	1	99999	99999	99999	99999	99999	99999
3160	20	008 29	203	2	08089	00762	06441	04935	00759	00757
3160	20	008 29	203	3	11135	04713	10685	03208	04705	04631
3160	20	008 29	203	4	10318	04576	10130	02001	04573	04504
3160	20	008 29	203	5	09705	04985	09202	03137	04977	04920
3160	40	008 29	203	1	10012	00468	09881	01649-	00467	00460
3160	40	008 29	203	2	08795	04322	08339	02837	04316	04276
3160	40	008 29	203	3	09188	05423	08919	02242	05418	05357
3160	40	008 29	203	4	07975	05159	07535	02644	05153	05114
3160	40	008 29	203	5	07592	05445	06952	03080	05437	05405

General Notes:

1. The decimal location has been indicated by the vertical lines on the first page of this table.
2. Negative values in the table are followed by a negative sign.

TABLE 6

PART a (continued)

Code No.	α deg	ø deg-min		V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_α lb/ft^2	q_β lb/ft^2
3160	60	008	29	203	1	02321	01183	02313	00188	01182	01182
3160	60	008	29	203	2	07285	05805	06870	02445	05799	05763
3160	60	008	29	203	3	05806	05675	05305	02371	05670	05650
3160	60	008	29	203	4	04087	05397	03343	02356	05392	05387
3160	60	008	29	203	5	05038	05481	04127	02900	05474	05466
3160	80	008	29	203	1	02480	02830	01070	02238-	02827	02829
3160	80	008	29	203	2	04844	05927	04063	02645	05920	05912
3160	80	008	29	203	3	03243	05675	02324	02264	05670	05670
3160	80	008	29	203	4	02982	05392	01095	02774	05385	05390
3160	80	008	29	203	5	04386	05439	02375	03691	05427	05434
3170	00	008	29	405	1	99999	99999	99999	99999	99999	99999
3170	00	008	29	405	2	99999	99999	99999	99999	99999	99999
3170	00	008	29	405	3	99999	99999	99999	99999	99999	99999
3170	00	008	29	405	4	17244	01004	15279	08383-	00993	00969
3170	00	008	29	405	5	15618	02779	15493	02070	02777	02678
3170	20	008	29	405	1	99999	99999	99999	99999	99999	99999
3170	20	008	29	405	2	99999	99999	99999	99999	99999	99999
3170	20	008	29	405	3	01593	00000	00750	01406	00000	00000
3170	20	008	29	405	4	20396	01675	20350	01501-	01674	01570
3170	20	008	29	405	5	19484	04093	19359	02377	04089	03861
3170	40	008	29	405	1	99999	99999	99999	99999	99999	99999
3170	40	008	29	405	2	16430	01980	16430	00066	01979	01899
3170	40	008	29	405	3	17821	04062	17814	00537	04061	03867
3170	40	008	29	405	4	15507	04572	15458	01294	04570	04406
3170	40	008	29	405	5	14758	05238	14602	02231	05234	05069
3170	60	008	29	406	1	13685	01492	12923	04660	01487	01454
3170	60	008	29	406	2	10413	06060	10237	01949	06056	05963
3170	60	008	29	406	3	09380	05717	09176	01978	05713	05643
3170	60	008	29	406	4	07968	05709	07556	02559	05703	05659
3170	60	008	29	406	5	07140	06036	06399	03193	06026	05998
3170	80	008	29	406	1	06163	02545	06070	01073-	02544	02530
3170	80	008	29	406	2	07130	06356	06737	02355	06350	06312
3170	80	008	29	406	3	05707	06222	05038	02694	06215	06197
3170	80	008	29	406	4	04491	05903	03527	02787	05895	05891
3170	80	008	29	406	5	05070	05945	03711	03464	05934	05932
3180	00	008	29	611	1	99999	99999	99999	99999	99999	99999
3180	00	008	29	611	2	99999	99999	99999	99999	99999	99999
3180	00	008	29	611	3	99999	99999	99999	99999	99999	99999
3180	00	008	29	611	4	99999	99999	99999	99999	99999	99999
3180	00	008	29	611	5	02399	00000	02317-	00624	00000	00000
3180	10	008	29	612	1	99999	99999	99999	99999	99999	99999
3180	10	008	29	612	2	99999	99999	99999	99999	99999	99999
3180	10	008	29	612	3	99999	99999	99999	99999	99999	99999
3180	10	008	29	612	4	99999	99999	99999	99999	99999	99999
3180	10	008	29	612	5	24753	01298	17974	18140-	01239	01240
3180	20	008	29	612	1	99999	99999	99999	99999	99999	99999

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_c deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_α $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3180	20	008 29	612	2	99999	99999	99999	99999	99999	99999
3180	20	008 29	612	3	99999	99999	99999	99999	99999	99999
3180	20	008 29	612	4	01889	00000	00194	01879	00000	00000
3180	20	008 29	612	5	21788	01952	19876	09676-	01927	01838
3180	30	008 29	612	1	99999	99999	99999	99999	99999	99999
3180	30	008 29	612	2	99999	99999	99999	99999	99999	99999
3180	30	008 29	612	3	99999	99999	99999	99999	99999	99999
3180	30	008 29	612	4	99999	99999	99999	99999	99999	99999
3180	30	008 29	612	5	24109	03652	24057	01792-	03650	03335
3180	40	008 29	614	1	99999	99999	99999	99999	99999	99999
3180	40	008 29	614	2	28414	02732	28330	02595-	02729	02405
3180	40	008 29	614	3	22830	05304	22830	00094	05303	04888
3180	40	008 29	614	4	20035	05223	20026	00650-	05222	04907
3180	40	008 29	614	5	18424	05488	18408	00831	05487	05207
3180	50	008 29	614	1	28826	02896	27890	08581	02870	02565
3180	50	008 29	614	2	20031	03873	20018	00776-	03872	03639
3180	50	008 29	614	3	19107	05684	19093	00798	05683	05371
3180	50	008 29	614	4	17293	05460	17284	00614	05459	05213
5180	50	008 29	614	5	15451	05852	15388	01462	05850	05642
3180	60	008 29	615	1	18015	02631	17143	05881	02618	02515
3180	60	008 29	615	2	12019	06490	11978	01015	06489	06348
3180	60	008 29	615	3	11268	06354	11150	01662	06351	06234
3180	60	008 29	615	4	09815	06138	09502	02506	06132	06053
3180	60	008 29	615	5	08615	06718	08046	03118	06708	06651
3180	70	008 29	615	1	14327	03026	14192	02042	03024	02933
3180	70	008 29	615	2	10964	06695	10880	01387	06693	06574
3180	70	008 29	615	3	09265	06516	09065	01947	06512	06434
3180	70	008 29	615	4	08254	06259	07873	02510	06253	06200
3180	70	008 29	615	5	08155	06464	07490	03261	06453	06409
3180	80	008 29	617	1	09810	03701	09797	00520	03700	03646
3180	80	008 29	617	2	07309	07670	07187	01348	07667	07609
3180	80	008 29	617	3	05902	06936	05428	02331	06930	06904
3180	80	008 29	617	4	04682	06620	03590	03014	06610	06607
3180	80	008 29	617	5	05268	06704	03661	03798	06689	06690
3180	90	008 29	617	1	05873	04492	05862	00367-	04491	04468
3180	90	008 29	617	2	05408	07535	05320	00977	07533	07502
3180	90	008 29	617	3	03282	06894	02594	02013	06889	06886
3180	90	008 29	617	4	03235	06529	01170	03017	06519	06527
3180	90	008 29	617	5	04061	06655	01804	03641	06641	06651
3190	00	008 29	000	1	05236	03217	01994-	04845-	03205	03215
3190	00	008 29	000	2	02499	06048	01037	02274	06043	06046
3190	00	008 29	000	3	01501	05512	00148-	01494	05510	05512
3190	00	008 29	000	4	02907	05434	01290-	02606	05428	05432
3190	00	008 29	000	5	03979	05307	00297-	03968	05294	05306

PART b: Distance behind duct exit = 1.62 inches; β = 12 degrees

3370	00	008 29	205	1	22273	00089	21069	07856	00088	00083
3370	00	008 29	205	2	09288	00805	09099-	01893-	00804	00794

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b (continued)

Code No.	α deg	β deg-min	V ft/sec	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_α $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3370	00	008 29	205	3	07082	06222	05146	04891-	06199	06197
3370	00	008 29	205	4	07668	05619	04004	06561-	05582	05605
3370	00	008 29	205	5	08619	06675	02389	08291-	06605	06669
3370	20	008 29	205	1	99999	99999	99999	99999	99999	99999
3370	20	008 29	205	2	03563	03005	00399-	03541-	02999	03004
3370	20	008 29	205	3	07804	05843	04554	06364-	05807	05824
3370	20	008 29	205	4	07666	05915	04057	06526-	05876	05900
3370	20	008 29	205	5	07938	06922	01660	07767-	06858	06919
3370	40	008 29	205	1	05599	00847	05597-	00124-	00846	00842
3370	40	008 29	205	2	05278	05715	03430	04022-	05700	05704
3370	40	008 29	205	3	07454	06264	04428	06020-	06229	06245
3370	40	008 29	205	4	07881	06506	03907	06865-	06459	06491
3370	40	008 29	205	5	08072	07302	01694	07897-	07232	07298
3370	60	008 29	205	1	06175	02333	05772-	02209-	02331	02321
3370	60	008 29	205	2	05195	06562	02637	04483-	06541	06555
3370	60	008 29	205	3	07027	06642	03396	06166-	06603	06630
3370	60	008 29	205	4	07230	07013	02420	06821-	06963	07006
3370	60	008 29	205	5	07896	07597	00551	07877-	07525	07596
3370	80	008 29	205	1	06019	04157	05443-	02584-	04152	04138
3370	80	008 29	205	2	04870	06731	00882	04790-	06707	06730
3370	80	008 29	205	3	06422	06936	01094	06330-	06893	06934
3370	80	008 29	205	4	07122	06971	00500	07105-	06917	06970
3370	80	008 29	205	5	07672	07513	01022-	07605-	07446	07511
3380	00	008 29	407	1	99999	99999	99999	99999	99999	99999
3380	00	008 29	407	2	99999	99999	99999	99999	99999	99999
3380	00	008 29	407	3	99999	99999	99999	99999	99999	99999
3380	00	008 29	407	4	03977	02403	02802-	07827-	02400	02400
3380	00	008 29	407	5	06609	05022	01518	06435-	04990	05020
3380	20	008 29	407	1	99999	99999	99999	99999	99999	99999
3380	20	008 29	407	2	99999	99999	99999	99999	99999	99999
3380	20	008 29	407	3	07877	01471	06261	04818-	01465	01462
3380	20	008 29	407	4	12219	04722	11169	05082-	04704	04633
3380	20	008 29	407	5	09166	06084	06544	06474-	06045	06044
3380	40	008 29	408	1	99999	99999	99999	99999	99999	99999
3380	40	008 29	408	2	09657	04364	08537	04580-	04350	04315
3380	40	008 29	408	3	11837	05223	09816	06745-	05187	05147
3380	40	008 29	408	4	11769	06248	09093	07597-	06194	06170
3380	40	008 29	408	5	09778	07520	05834	07901-	07449	07481
3380	60	008 29	408	1	05206	01905	03064-	04217	01899	01902
3380	60	008 29	408	2	08146	06441	06196	05329-	06413	06403
3380	60	008 29	408	3	09136	06768	06392	06582-	06723	06726
3380	60	008 29	408	4	09815	07112	05796	07975-	07043	07076
3380	60	008 29	408	5	08873	07858	03047	08348-	07774	07847
3380	80	008 29	408	1	04045	04610	04045-	00001-	04610	04598
3380	80	008 29	408	2	05853	07289	02637	05232-	07258	07281
3380	80	008 29	408	3	06785	07315	02536	06301-	07270	07307

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.
2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_α $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3380	80	008 29	408	4	07602	07436	01910	07363-	07374	07431
3380	80	008 29	408	5	07883	08062	00075	07883-	07985	08062
3390	00	008 29	613	1	99999	99999	99999	99999	99999	99999
3390	00	008 29	613	2	99999	99999	99999	99999	99999	99999
3390	00	008 29	613	3	99999	99999	99999	99999	99999	99999
3390	00	008 29	613	4	99999	99999	99999	99999	99999	99999
3390	00	008 29	613	5	22739	00831	09775	20910-	00777	00820
3390	10	008 29	613	1	99999	99999	99999	99999	99999	99999
3390	10	008 29	613	2	99999	99999	99999	99999	99999	99999
3390	10	008 29	613	3	99999	99999	99999	99999	99999	99999
3390	10	008 29	613	4	99999	99999	99999	99999	99999	99999
3390	10	008 29	613	5	08797	02197	00366-	08790-	02171	02196
3390	20	008 29	613	1	99999	99999	99999	99999	99999	99999
3390	20	008 29	613	2	99999	99999	99999	99999	99999	99999
3390	20	008 29	613	3	99999	99999	99999	99999	99999	99999
3390	20	008 29	613	4	15547	00819	06289	14330-	00793	00814
3390	20	008 29	613	5	09893	04774	07976	05929-	04748	04728
3390	30	008 29	613	1	99999	99999	99999	99999	99999	99999
3390	30	008 29	613	2	99999	99999	99999	99999	99999	99999
3390	30	008 29	613	3	19312	02102	17108	09510-	02075	02011
3390	30	008 29	613	4	17962	03914	15666	09236-	03866	03772
3390	30	008 29	613	5	13044	06320	10217	08282-	06256	06221
3390	40	008 29	613	1	99999	99999	99999	99999	99999	99999
3390	40	008 29	613	2	13654	03361	11421	07684-	03331	03295
3390	40	008 29	613	3	16659	05269	14743	08108-	05219	05098
3390	40	008 29	613	4	15543	05952	12718	09234-	05878	05809
3390	40	008 29	613	5	11626	08043	08265	08290-	07960	07961
3390	50	008 29	613	1	33051	01353	24581	24833	01247	01249
3390	50	008 29	613	2	11590	06023	09727	06424-	05986	05937
3390	50	008 29	613	3	13643	06506	11270	07888-	06446	06382
3390	50	008 29	613	4	13410	07005	10128	08972-	06921	06898
3390	50	008 29	613	5	10847	08628	06365	08855-	08526	08576
3390	60	008 29	613	1	08275	03017	03065	07701	02989	03012
3390	60	008 29	613	2	09938	07119	07957	06030-	07080	07051
3390	60	008 29	613	3	11358	07154	08526	07614-	07092	07076
3390	60	008 29	613	4	11042	07635	07041	08591-	07550	07578
3390	60	008 29	613	5	09083	09084	03895	08230-	08990	09063
3390	70	008 29	614	1	03291	05154	01560-	02900	05147	05152
3390	70	008 29	614	2	07350	08051	04136	06097-	06005	08030
3390	70	008 29	614	3	08300	08029	04206	07181-	07966	08007
3390	70	008 29	614	4	08342	08416	03135	07746-	08339	08403
3390	70	008 29	614	5	08489	09084	00768	08455-	08985	09083
3390	80	008 29	614	1	03047	05366	01354-	02730	05359	05364
3390	80	008 29	614	2	07133	08306	03458	06254-	08256	08291
3390	80	008 29	614	3	07344	08240	02911	06754-	08182	08229
3390	80	008 29	614	4	07981	08416	02004	07732-	08339	08410-

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

P[illegible] K (continued)

Code No.	α deg	ϑ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_α lb/ft^2	q_β lb/ft^2
3390	80	008 29	614	5	08432	09084	00030-	08432-	08985	09083
3390	90	008 29	614	1	06128	06320	05592-	02521	06313	06289
3390	90	008 29	614	2	06608	08348	00896	06548-	08293	08346
3390	90	008 29	614	3	07060	08240	00240	07056-	08177	08239
3390	90	008 29	614	4	07475	08619	00255-	07470-	08545	08618
3390	90	008 29	614	5	08939	08957	01878-	08746-	08952	08952
3400	00	008 29	000	1	09006	04084	07865-	04444-	04071	04045
3400	00	008 29	000	2	05044	06816	01566-	04797-	06792	06813
3400	00	008 29	000	3	06450	06768	00715-	06410-	06725	06767
3400	00	008 29	000	4	07042	06760	01489-	06886-	06711	06757
3400	00	008 29	000	5	06168	07140	02791-	07688-	07075	07131
3330	00	045 00	204	1	99999	99999	99999	99999	99999	99999
3330	00	045 00	204	2	10003	04850	11451	11476-	04756	04757
3330	00	045 00	204	3	14618	05382	11756	08935-	05319	05271
3330	00	045 00	204	4	13809	05558	11369	08046-	05505	05450
3330	00	045 00	204	5	14480	06132	11525	09005-	06059	06011
3330	20	045 00	204	1	05316	01822	05306-	00328	01821	01814
3330	20	045 00	204	2	09489	05551	08453	04375-	05535	05491
3330	20	045 00	204	3	10670	05633	09393	05152-	05610	05558
3330	20	045 00	204	4	11682	05823	09795	06491-	05786	05739
3330	20	045 00	204	5	12573	06356	09933	07863-	06297	06262
3330	40	045 00	204	1	05070	01862	04633-	02070	01860	01855
3330	40	045 00	204	2	09397	05890	08982	02809-	05883	05817
3330	40	045 00	204	3	09511	05927	08910	03382-	05916	05855
3330	40	045 00	204	4	10021	05937	08645	05145-	05908	05865
3330	40	045 00	204	5	10934	06090	08891	06467-	06052	06017
3330	60	045 00	204	1	05272	02751	05271-	00127-	02750	02739
3330	60	045 00	204	2	07174	06060	06976	01693-	06057	06015
3330	60	045 00	204	3	07468	05843	06856	02991-	05835	05801
3330	60	045 00	204	4	07558	05661	06350	04132-	05646	05626
3330	60	045 00	204	5	08332	05704	06347	05442-	05678	05669
3330	80	045 00	204	1	04719	03640	03677-	02697-	03635	03631
3330	80	045 00	204	2	04279	06011	04212	00758-	06010	05994
3330	80	045 00	204	3	04430	05759	03909	02092-	05755	05745
3330	80	045 00	204	4	04856	05566	03466	03407-	05556	05555
3330	80	045 00	204	5	05328	05566	03254	04228-	05550	05557
3340	00	045 00	407	1	99999	99999	99999	99999	99999	99999
3340	00	045 00	407	2	99999	99999	99999	99999	99999	99999
3340	00	045 00	407	3	99999	99999	99999	99999	99999	99999
3340	00	045 00	407	4	21304	03857	18069	12058-	03779	03674
3340	00	045 00	407	5	20714	05095	18052	10853-	05012	04852
3340	20	045 00	407	1	99999	99999	99999	99999	99999	99999
3340	20	045 00	407	2	99999	99999	99999	99999	99999	99999
3340	20	045 00	407	3	20639	04261	24306	12311-	04179	03898
3340	20	045 00	407	4	27653	05485	25257	12841-	05371	04983
3340	20	045 00	407	5	23676	06086	21549	11307-	05983	05675

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b (continued)

Code No.	α deg	ø deg-min	V ft/sec	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3340	40	045 00	407	1	99999	99999	99999	99999	99999	99999
3340	40	045 00	407	2	18114	05580	16936	06816-	05543	05341
3340	40	045 00	407	3	18419	06123	17361	06543-	06086	05847
3340	40	045 00	407	4	20289	06192	18587	08731-	06127	05875
3340	40	045 00	407	5	19602	06615	17465	09471-	06532	06317
3340	60	045 00	407	1	09575	03276	08051-	05252	03262	03243
3340	60	045 00	407	2	12262	06320	11524	04305-	06302	06193
3340	60	045 00	407	3	12601	06409	11391	05532-	06380	06283
3340	60	045 00	407	4	13426	06279	11743	06694-	06237	06149
3340	60	045 00	407	5	13673	06581	11503	07592-	06525	06450
3340	80	045 00	407	1	03114	04943	03113-	00072-	04943	04935
3340	80	045 00	407	2	06032	06441	05678	02051-	06436	06409
3340	80	045 00	407	3	06283	06222	05467	03114-	06212	06193
3340	80	045 00	407	4	06983	05915	05243	04637-	05895	05890
3340	80	045 00	407	5	07583	06036	05430	05324-	06010	06009
3350	00	045 00	611	1	99999	99999	99999	99999	99999	99999
3350	00	045 00	611	2	99999	99999	99999	99999	99999	99999
3350	00	045 00	611	3	99999	99999	99999	99999	99999	99999
3350	00	045 00	611	4	99999	99999	99999	99999	99999	99999
3350	00	045 00	611	5	99999	99999	99999	99999	99999	99999
3350	10	045 00	612	1	99999	99999	99999	99999	99999	99999
3350	10	045 00	612	2	99999	99999	99999	99999	99999	99999
3350	10	045 00	612	3	99999	99999	99999	99999	99999	99999
3350	10	045 00	612	4	99999	99999	99999	99999	99999	99999
3350	10	045 00	612	5	27507	05053	26866	06872-	05023	04514
3350	20	045 00	613	1	99999	99999	99999	99999	99999	99999
3350	20	045 00	613	2	99999	99999	99999	99999	99999	99999
3350	20	045 00	613	3	99999	99999	99999	99999	99999	99999
3350	20	045 00	613	4	99999	99999	99999	99999	99999	99999
3350	20	045 00	613	5	99999	99999	99999	99999	99999	99999
3350	30	045 00	613	1	99999	99999	99999	99999	99999	99999
3350	30	045 00	613	2	28407	04447	25300	14726-	04326	04044
3350	30	045 00	613	3	99999	99999	99999	99999	99999	99999
3350	30	045 00	613	4	99999	99999	99999	99999	99999	99999
3350	30	045 00	613	5	99999	99999	99999	99999	99999	99999
3350	40	045 00	613	1	99999	99999	99999	99999	99999	99999
3350	40	045 00	613	2	23491	06333	22029	09017-	06265	05880
3350	40	045 00	613	3	25066	06806	23510	09748-	06723	06255
3350	40	045 00	613	4	99999	99999	99999	99999	99999	99999
3350	40	045 00	613	5	26840	07846	24430	12568-	07691	07174
3350	50	045 00	615	1	23928	03686	18693-	16017	03556	03505
3350	50	045 00	615	2	18101	07063	16973	06672-	07019	06759
3350	50	045 00	615	3	17935	07001	16617	07140-	06951	06712
3350	50	045 00	615	4	19130	06946	17232	08826-	06870	06641
3350	50	045 00	615	5	19120	07498	16872	09533-	07402	07183
3350	60	045 00	615	1	17597	04430	12640-	12641	04327	04327

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3350	60	045 00	615	2	15259	07140	14278	05613-	07107	06921
3350	60	045 00	615	3	15252	06928	13890	06553-	06885	06727
3350	60	045 00	615	4	16307	06805	14447	07891-	06744	06593
3350	60	045 00	615	5	16299	07376	14089	08532-	07299	07158
3350	70	045 00	615	1	09987	05360	07300-	06889	05321	05317
3350	70	045 00	615	2	11023	07373	10303	04003-	07355	07254
3350	70	045 00	615	3	11487	06985	10349	05096-	06958	06872
3350	70	045 00	615	4	12193	06935	10488	06358-	06893	06820
3350	70	045 00	615	5	12785	07204	10374	07636-	07142	07088
3350	80	045 00	615	1	06074	06023	04358-	04247	06006	06005
3350	80	045 00	615	2	08258	07331	07639	03173-	07319	07266
3350	80	045 00	615	3	08397	07147	07240	04297-	07127	07090
3350	80	045 00	615	4	09672	06604	07580	06077-	06567	06546
3350	80	045 00	615	5	10327	06893	07625	07048-	06841	06832
3350	90	045 00	615	1	05151	07324	04494-	02527-	07316	07301
3350	90	045 00	615	2	03636	07705	01257	03413-	07691	07703
3350	90	045 00	615	3	04810	06936	01553	04554-	06914	06933
3350	90	045 00	615	4	05717	06711	01771	05439-	06680	06707
3350	90	045 00	615	5	06571	06415	02567	06057-	06379	06408
3360	00	045 00	000	1	06319	03563	04786-	04144-	03553	03550
3360	00	045 00	000	2	01650	06048	01214	01117-	06046	06046
3360	00	045 00	000	3	02693	05591	01763	02037-	05587	05588
3360	00	045 00	000	4	02850	05434	00560	02794-	05427	05433
3360	00	045 00	000	5	02804	05265	00169	02799-	05258	05264
3290	00	089 45	204	1	05057	08001	02892-	04155-	07979	07990
3290	00	089 45	204	2	11233	06992	09350	06338-	06950	06900
3290	00	089 45	204	3	13814	06048	12135	06802-	06007	05914
3290	00	089 45	204	4	16108	05759	14471	07382-	05714	05579
3290	00	089 45	204	5	17992	05467	16338	07957-	05418	05250
3290	20	089 45	204	1	09708	06041	07843-	05791-	06010	05984
3290	20	089 45	204	2	11109	06611	10723	02972-	06602	06495
3290	20	089 45	204	3	11508	06144	11015	03416-	06133	06031
3290	20	089 45	204	4	14795	05542	13936	05169-	05520	05380
3290	20	089 45	204	5	15858	05478	14835	05861-	05451	05297
3290	40	089 45	205	1	08261	05270	07010-	04415-	05254	05230
3290	40	089 45	205	2	08248	06526	08223	00659-	06525	06458
3290	40	089 45	205	3	09060	05969	08857	01934-	05965	05897
3290	40	089 45	205	4	10859	05599	10471	02941-	05591	05505
3290	40	089 45	205	5	12073	05588	11355	04210-	05573	05479
3290	60	089 45	205	1	06324	04920	04756-	04187-	04906	04903
3290	60	089 45	205	2	06895	06229	06894	00025-	06228	06183
3290	60	089 45	205	3	07287	05759	07256	00680-	05758	05712
3290	60	089 45	205	4	09157	05503	08768	02680-	05497	05438

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 5

PART b (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_α $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3290	60	089 45	205	5	09979	05281	09364	03513-	05271	05210
3290	80	089 45	205	1	03996	04736	00923-	03889-	04725	04735
3290	80	089 45	205	2	03832	06223	03805	00459	06222	06209
3290	80	089 45	205	3	04424	05717	04383	00602-	05716	05700
3290	80	089 45	205	4	05469	05360	05304	01340-	05358	05337
3290	80	089 45	205	5	05779	05397	05336	02231-	05392	05373
3300	00	089 45	409	1	99999	99999	99999	99999	99999	99999
3300	00	089 45	409	2	99999	99999	99999	99999	99999	99999
3300	00	089 45	409	3	99999	99999	99999	99999	99999	99999
3300	00	089 45	409	4	99999	99999	99999	99999	99999	99999
3300	00	089 45	409	5	99999	99999	99999	99999	99999	99999
3300	20	089 45	409	1	99999	99999	99999	99999	99999	99999
3300	20	089 45	409	2	31802	09094	29724	13598-	08899	07951
3300	20	089 45	409	3	99999	99999	99999	99999	99999	99999
3300	20	089 45	409	4	99999	99999	99999	99999	99999	99999
3300	20	089 45	409	5	99999	99999	99999	99999	99999	99999
3300	40	089 45	409	1	17855	07110	15495-	09316-	07022	06857
3300	40	089 45	409	2	19255	07586	18712	04882-	07561	07187
3300	40	089 45	409	3	19335	07016	18854	04612-	06995	06641
3300	40	089 45	409	4	21875	06811	21243	05732-	06781	06352
3300	40	089 45	409	5	22677	06550	21961	06248-	06516	06079
3300	60	089 45	409	1	10868	06558	09510-	05357-	06530	06468
3300	60	089 45	409	2	14383	06266	14234	02152-	06261	06073
3300	60	089 45	409	3	12903	06831	12715	02268-	06825	06663
3300	60	089 45	409	4	15741	06260	15332	03737-	06247	06038
3300	60	089 45	409	5	16226	06046	15675	04408-	06029	05822
3300	80	089 45	409	1	05516	05848	04524-	03169-	05839	05829
3300	80	089 45	409	2	07545	06865	07543	00149	06864	06805
3300	80	089 45	409	3	08255	06558	08229	00663-	06557	06490
3300	80	089 45	409	4	09822	05969	09600	02119-	05964	05885
3300	80	089 45	409	5	09757	05915	09511	02969-	05907	05837
3310	00	089 45	614	1	99999	99999	99999	99999	99999	99999
3310	00	089 45	614	2	99999	99999	99999	99999	99999	99999
3310	00	089 45	614	3	99999	99999	99999	99999	99999	99999
3310	00	089 45	614	4	99999	99999	99999	99999	99999	99999
3310	00	089 45	614	5	99999	99999	99999	99999	99999	99999
3310	10	089 45	614	1	99999	99999	99999	99999	99999	99999
3310	10	089 45	614	2	99999	99999	99999	99999	99999	99999
3310	10	089 45	614	3	99999	99999	99999	99999	99999	99999
3310	10	089 45	614	4	99999	99999	99999	99999	99999	99999
3310	10	089 45	614	5	99999	99999	99999	99999	99999	99999
3310	20	089 45	614	1	99999	99999	99999	99999	99999	99999
3310	20	089 45	614	2	99999	99999	99999	99999	99999	99999
3310	20	089 45	614	3	99999	99999	99999	99999	99999	99999
3310	20	089 45	614	4	99999	99999	99999	99999	99999	99999
3310	20	089 45	614	5	99999	99999	99999	99999	99999	99999

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 6

PART b (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_α $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3310	30	089 45	614	1	99999	99999	99999	99999	99999	99999
3310	30	089 45	614	2	99999	99999	99999	99999	99999	99999
3310	30	089 45	614	3	99999	99999	99999	99999	99999	99999
3310	30	089 45	614	4	99999	99999	99999	99999	99999	99999
3310	30	089 45	614	5	99999	99999	99999	99999	99999	99999
3310	40	089 45	615	1	23109	08854	20650-	11318-	08702	08305
3310	40	089 45	615	2	25507	09096	24752	06999-	09041	08272
3310	40	089 45	615	3	25353	08207	24698	06502-	08163	07464
3310	40	089 45	615	4	99999	99999	99999	99999	99999	99999
3310	40	089 45	615	5	28914	08095	28385	06534-	08054	07132
3310	50	089 45	615	1	19302	08598	17395-	08899-	08503	08213
3310	50	089 45	615	2	21764	08720	21153	05615-	08683	08137
3310	50	089 45	615	3	21798	07923	21279	05194-	07894	07386
3310	50	089 45	615	4	24544	07859	23875	06409-	07817	07193
3310	50	089 45	615	5	25711	07569	25140	06155-	07533	06859
3310	60	089 45	615	1	13647	08048	12443-	05785-	08008	07860
3310	60	089 45	615	2	16512	08085	16289	02857-	08075	07761
3310	60	089 45	615	3	16720	07532	16467	03059-	07522	07223
3310	60	089 45	615	4	18987	07325	18581	04193-	07307	06945
3310	60	089 45	615	5	18650	07149	18174	04480-	07129	06794
3310	70	089 45	615	1	11126	07275	10453-	03896-	07258	07154
3310	70	089 45	615	2	13352	08025	13298	01241-	08023	07809
3310	70	089 45	615	3	14032	07393	13875	02179-	07387	07177
3310	70	089 45	615	4	15748	06858	15470	03096-	06848	06610
3310	70	089 45	615	5	15866	06840	15446	03806-	06825	06593
3310	80	089 45	615	1	10146	07225	08726-	05256-	07195	07142
3310	80	089 45	615	2	11052	07831	10910	01812-	07827	07689
3310	80	089 45	615	3	11415	07188	11230	02100-	07183	07050
3310	80	089 45	615	4	12587	06849	12187	03244-	06838	06695
3310	80	089 45	615	5	12825	06519	12271	03845-	06504	06370
3310	90	089 45	615	1	07344	07550	03019-	06707-	07498	07539
3310	90	089 45	615	2	06258	07535	05563	02884-	07525	07499
3310	90	089 45	615	3	06964	07055	06330	02927-	07045	07012
3310	90	089 45	615	4	08035	06633	07076	03844-	06618	06582
3310	90	089 45	615	5	07780	06367	06786	03841-	06352	06322
3320	00	089 45	005	1	06389	04195	04256	04782-	04180	04183
3320	00	089 45	005	2	00957	06041	00885	00364	06040	06040
3320	00	089 45	005	3	02589	05417	02586	00135-	05416	05411
3320	00	089 45	005	4	02428	05386	02072	01266-	05384	05382
3320	00	089 45	005	5	02479	05218	02113	01297-	05216	05214
3250	00	135 13	204	1	05947	07450	03409	04885-	07422	07436
3250	00	135 13	204	2	08118	07366	08116	00199-	07365	07292
3250	00	135 13	204	3	10267	06341	10266	00126-	06340	06239
3250	00	135 13	204	4	11793	05986	11754	00989-	05985	05860
3250	00	135 13	204	5	11760	05582	11650	0165	05579	05467
3250	20	135 13	204	1	05874	06858	03255	0490	06832	06846

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b (continued)

Code No.	α deg	∅ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft²	i_α deg	i_β deg	q_α lb/ft²	q_β lb/ft²
3250	20	135 13	204	2	07949	06815	07935	00491	06814	06749
3250	20	135 13	204	3	09585	06089	09583	00233	06088	06003
3250	20	135 13	204	4	10686	05890	10680	00372-	05889	05787
3250	20	135 13	204	5	10863	05408	10812	0107	05407	05311
3250	40	135 13	204	1	05585	06392	03907	04004-	06376	06377
3250	40	135 13	204	2	07085	06392	07069	00489	06391	06343
3250	40	135 13	204	3	08284	05963	08283	00094	05962	05900
3250	40	135 13	204	4	09191	05624	09189	00227-	05623	05551
3250	40	135 13	204	5	08863	05529	08820	00833-	05528	05463
3250	60	135 13	204	1	04936	05794	03888	0305	05785	05780
3250	60	135 13	204	2	05978	06392	05951	00562	06391	06357
3250	60	135 13	204	3	06890	05753	06890	00088	05752	05711
3250	60	135 13	204	4	07967	05450	07929	00734-	05449	05397
3250	60	135 13	204	5	07339	05608	07249	01159-	05606	05563
3250	80	135 13	205	1	04090	05661	04029	00705-	05660	05646
3250	80	135 13	205	2	02759	06168	02750	00222	06167	06160
3250	80	135 13	205	3	02996	05627	02981	00304-	05626	05619
3250	80	135 13	205	4	04055	05349	03806	01404-	05347	05337
3250	80	135 13	205	5	03736	05596	03418	01511-	05594	05586
3260	00	135 13	410	1	19066	10787	12079	15184-	10426	10564
3260	00	135 13	410	2	19706	09167	18622	06922-	09106	08693
3260	00	135 13	410	3	21602	07265	20944	05793-	07232	06789
3260	00	135 13	410	4	24710	06364	24481	03806-	06352	05794
3260	00	135 13	410	5	24161	06019	24143	01039-	06018	05492
3260	20	135 13	418	1	14686	09927	06226	13404-	09659	09871
3260	20	135 13	418	2	16620	08691	16493	02167-	08685	08333
3260	20	135 13	418	3	18990	07065	18908	01907-	07061	06684
3260	20	135 13	418	4	21377	06424	21365	00808-	06423	05982
3260	20	135 13	418	5	22794	06228	22787	00629	06227	05741
3260	40	135 13	418	1	12132	09227	04036	11478-	09043	09205
3260	40	135 13	418	2	14044	08206	14019	00877-	08205	07961
3260	40	135 13	418	3	14819	07115	14807	00626-	07114	06878
3260	40	135 13	418	4	17561	06386	17542	00865-	06385	06089
3260	40	135 13	418	5	17617	06004	17601	00783-	06003	05722
3260	60	135 13	418	1	08429	08020	01855	08228-	07937	08015
3260	60	135 13	418	2	10434	07616	10422	00519	07615	07490
3260	60	135 13	418	3	10869	06974	10868	00134-	06973	06848
3260	60	135 13	418	4	13072	06171	13059	00602-	06170	06011
3260	60	135 13	418	5	13287	05802	13230	0128	05800	05648
3260	80	135 13	418	1	06696	07496	03694	0560	07460	07480
3260	80	135 13	418	2	06576	07319	06554	00545-	07318	07271
3260	80	135 13	418	3	07346	06422	07321	00618-	06421	06369
3260	80	135 13	418	4	08266	05869	08183	01184-	05867	05809
3260	80	135 13	418	5	07967	05900	07800	0164	05897	05845
3270	00	135 13	608	1	99999	99999	99999	99999	99999	99999
3270	00	135 13	608	2	99999	99999	99999	99999	99999	99999

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3270	00	135 13	608	3	99999	99999	99999	99999	99999	99999
3270	00	135 13	608	4	99999	99999	99999	99999	99999	99999
3270	00	135 13	608	5	99999	99999	99999	99999	99999	99999
3270	10	135 13	610	1	99999	99999	99999	99999	99999	99999
3270	10	135 13	610	2	30776	12066	29838	09105-	11950	10499
3270	10	135 13	610	3	99999	99999	99999	99999	99999	99999
3270	10	135 13	610	4	99999	99999	99999	99999	99999	99999
3270	10	135 13	610	5	99999	99999	99999	99999	99999	99999
3270	20	135 13	610	1	29857	13902	14267	27232-	12440	13559
3270	20	135 13	610	2	27785	11658	27216	06542-	11597	10381
3270	20	135 13	610	3	30099	08942	29851	04668-	08919	07761
3270	20	135 13	610	4	35997	08680	35968	01922-	08676	07026
3270	20	135 13	610	5	33757	07453	33752	00718-	07452	06196
3270	30	135 13	610	1	23648	12418	09651	21975-	11538	12266
3270	30	135 13	610	2	23170	11009	22894	03981-	10986	10145
3270	30	135 13	610	3	24583	08573	24454	02853-	08564	07605
3270	30	135 13	610	4	28450	08109	28432	01178-	08107	07131
3270	30	135 13	610	5	28520	07657	28512	00827-	07656	06728
3270	40	135 13	610	1	17487	11039	05793	16608-	10582	10987
3270	40	135 13	610	2	17764	10112	17705	01535-	10108	09633
3270	40	135 13	610	3	19030	08146	18970	01616-	08143	07703
3270	40	135 13	610	4	21522	07623	21488	01318-	07621	07093
3270	40	135 13	610	5	22322	07168	22274	01609-	07165	06633
3270	50	135 13	610	1	14585	10653	03908	14094-	10333	10629
3270	50	135 13	610	2	16098	09563	16083	00727-	09562	09188
3270	50	135 13	610	3	16550	08110	16522	01019-	08108	07775
3270	50	135 13	610	4	19134	07455	19127	00551-	07454	07043
3270	50	135 13	610	5	19144	06946	19103	01365-	06944	06563
3270	60	135 13	610	1	14951	09968	04652	14269-	09662	09937
3270	60	135 13	610	2	14598	09412	14591	00469-	09411	09100
3270	60	135 13	610	3	14582	08157	14573	00521-	08156	07894
3270	60	135 13	610	4	16138	07511	16100	01159-	07509	07216
3270	60	135 13	610	5	16689	06640	16650	0121	06638	06361
3270	70	135 13	612	1	10238	10237	05350	08779-	10116	10193
3270	70	135 13	612	2	10583	09135	10407	01968-	09129	08986
3270	70	135 13	612	3	11603	07890	11443	0197	07885	07733
3270	70	135 13	612	4	12265	07422	12153	01705-	07418	07255
3270	70	135 13	612	5	12312	06628	12126	02194-	06623	06480
3270	80	135 13	612	1	08248	10099	05186	06448-	10035	10058
3270	80	135 13	612	2	08764	09092	08505	02145-	09085	08992
3270	80	135 13	612	3	09380	07966	09170	02006-	07961	07864
3270	80	135 13	612	4	10719	07102	10472	02339-	07096	06983
3270	80	135 13	612	5	10203	06699	09894	02541-	06692	06599
3270	90	135 13	612	1	06842	09749	05662	03866-	09727	09701
3270	90	135 13	612	2	06328	08837	05513	03125-	08823	08796
3270	90	135 13	612	3	06381	07797	05907	02432-	07789	07755

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3270	90	135 13	612	4	07330	06905	06726	0294	06895	06857
3270	90	135 13	612	5	07260	06686	06487	03287-	06675	06643
3260	00	135 13	000	1	04589	05136	04586	00179-	05135	05119
3260	00	135 13	000	2	00956	05936	00687	00664-	05935	05935
3260	00	135 13	000	3	01684	05353	01656	00308-	05352	05350
3260	00	135 13	000	4	02674	05575	02209	01508-	05573	05570
3260	00	135 13	000	5	02849	05532	02127	01897-	05528	05528
3210	00	166 34	203	1	06250	07350	06233	00454-	07349	07306
3210	00	166 34	203	2	04871	07802	04283	02327-	07795	07780
3210	00	166 34	203	3	06136	07410	04018	04652-	07385	07391
3210	00	166 34	203	4	07939	07540	04850	06315-	07494	07513
3210	00	166 34	203	5	09540	07871	04964	08188-	07791	07842
3210	20	166 34	203	1	06158	07137	06129	00595-	07136	07096
3210	20	166 34	203	2	04736	07547	04218	02163-	07541	07526
3210	20	166 34	203	3	05803	07410	04058	04162-	07390	07391
3210	20	166 34	203	4	06927	07321	04273	05472-	07287	07300
3210	20	166 34	203	5	09018	07659	04516	07838-	07587	07635
3210	40	166 34	203	1	06283	06585	06200	01027-	06583	06546
3210	40	166 34	203	2	04167	07250	03686	01950-	07245	07235
3210	40	166 34	203	3	04994	07158	03429	03639-	07143	07145
3210	40	166 34	203	4	07046	06982	03938	05861-	06945	06965
3210	40	166 34	203	5	08291	07363	04570	06947-	07309	07339
3210	60	166 34	203	1	05253	06530	05251	00145	06529	06502
3210	60	166 34	203	2	03743	07081	02864	02414-	07074	07072
3210	60	166 34	203	3	04942	06905	02710	04139-	06887	06897
3210	60	166 34	203	4	06787	06770	03598	05770-	06735	06756
3210	60	166 34	203	5	08308	07363	03961	07326-	07303	07345
3210	80	166 34	203	1	04815	06402	04679	01141	06400	06380
3210	80	166 34	203	2	03007	06996	01936	02303-	06990	06991
3210	80	166 34	203	3	04593	06779	02172	04051-	06762	06774
3210	80	166 34	203	4	06661	06813	02742	06079-	06774	06805
3210	80	166 34	203	5	08559	07278	03153	07973-	07207	07267
3220	00	166 34	405	1	11593	09853	11003	03733-	09832	09672
3220	00	166 34	405	2	10960	09592	10647	02660-	09582	09427
3220	00	166 34	405	3	11606	08902	10901	04649-	08873	08742
3220	00	166 34	405	4	12958	08411	11127	06809-	08353	08254
3220	00	166 34	405	5	16061	07294	11296	11712-	07147	07158
3220	20	166 34	405	1	10914	09171	10377	03457-	09154	09021
3220	20	166 34	405	2	10446	09252	10272	01940-	09246	09103
3220	20	166 34	405	3	10793	08472	10098	03889-	08453	08341
3220	20	166 34	405	4	11622	08301	10248	05600-	08262	08169
3220	20	166 34	405	5	13563	07910	09709	09681-	07800	07799
3220	40	166 34	405	1	10231	08778	10106	01625-	08774	08641
3220	40	166 34	405	2	08702	08828	08414	02253-	08821	08733
3220	40	166 34	405	3	09187	08337	08343	03903-	08318	08249
3220	40	166 34	405	4	10186	08319	08522	05649-	08279	08228

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART b (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft²	i_α deg	i_β deg	q_α lb/ft²	q_β lb/ft²
3220	40	166 34	405	5	12027	08183	08524	08609-	08092	08094
3220	60	166 34	405	1	09216	08522	09208	00393-	08521	08412
3220	60	166 34	405	2	07948	08361	07602	02347-	08354	08287
3220	60	166 34	405	3	07892	08084	06790	04058-	08064	08027
3220	60	166 34	405	4	08988	08014	07055	05624-	07975	07953
3220	60	166 34	405	5	10551	08006	06871	08083-	07927	07949
3220	80	166 34	405	1	07254	08038	07254	00027	08037	07973
3220	80	166 34	405	2	06115	08149	05467	02756-	08139	08112
3220	80	166 34	405	3	06895	07747	05226	04523-	07723	07714
3220	80	166 34	405	4	07951	07667	05430	05843-	07627	07632
3220	80	166 34	405	5	09782	07913	05598	08072-	07835	07875
3230	00	166 34	608	1	19595	12346	18673	06381-	12277	11703
3230	00	166 34	608	2	16477	11685	16285	02648-	11673	11217
3230	00	166 34	608	3	17333	10046	16716	04854-	10012	09624
3230	00	166 34	608	4	17134	08523	15735	07131-	08461	08208
3230	00	166 34	608	5	17081	07078	14289	09755-	06981	06864
3230	10	166 34	609	1	18333	11676	17093	07035-	11595	11167
3230	10	166 34	609	2	15939	11608	15824	02016-	11601	11168
3230	10	166 34	609	3	16286	09754	15934	03548-	09736	09380
3230	10	166 34	609	4	16025	08926	14865	06261-	08876	08630
3230	10	166 34	609	5	14830	08155	12658	07982-	08079	07960
3230	20	166 34	609	1	16810	11596	16107	05074-	11553	11144
3230	20	166 34	609	2	15191	11391	14997	02538-	11380	11003
3230	20	166 34	609	3	15270	09834	14732	04199-	09809	09512
3230	20	166 34	609	4	15215	09141	13940	06342-	09088	08874
3230	20	166 34	609	5	14827	08539	12377	08420-	08451	08344
3230	30	166 34	610	1	13925	11186	13784	02053-	11179	10864
3230	30	166 34	610	2	12264	11174	11810	03401-	11155	10938
3230	30	166 34	610	3	12733	09967	11933	04655-	09935	09754
3230	30	166 34	610	4	13250	09445	11743	06310-	09390	09249
3230	30	166 34	610	5	14624	09171	10854	10026-	09035	09011
3230	40	166 34	610	1	12539	10749	12448	01555-	10745	10496
3230	40	166 34	610	2	11089	10950	10673	03080-	10934	10761
3230	40	166 34	610	3	11456	09820	10617	04401-	09791	09652
3230	40	166 34	610	4	12158	09460	10744	05826-	09412	09295
3230	40	166 34	610	5	13898	08982	10155	09687-	08857	08845
3230	50	166 34	611	1	13561	10717	13422	02006-	10710	10424
3230	50	166 34	611	2	10941	10653	10548	02472-	10639	10473
3230	50	166 34	611	3	10786	09525	09905	04354-	09498	09383
3230	50	166 34	611	4	11262	09058	09575	06041-	09009	08933
3230	50	166 34	611	5	12913	08879	09253	09164-	08768	08766
3230	60	166 34	611	1	11257	10877	11171	01418-	10873	10671
3230	60	166 34	611	2	09780	10611	09355	02905-	10597	10470
3230	60	166 34	611	3	10091	09558	09139	04352-	09531	09437
3230	60	166 34	611	4	10900	09049	09047	06181-	08997	08937
3230	60	166 34	611	5	12664	08913	09211	08840-	08809	08600

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8 PART c

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_τ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3230	70	166 34	611	1	09920	10696	09887	00826-	10694	10537
3230	70	166 34	611	2	09015	10314	08506	03030-	10299	10200
3230	70	166 34	611	3	09557	09305	08477	04479-	09277	09203
3230	70	166 34	611	4	10548	08922	08674	06094-	08872	08821
3230	70	166 34	611	5	11731	08862	08288	08417-	08768	08771
3230	80	166 34	611	1	07888	10557	07887	00148	10556	10457
3230	80	166 34	611	2	07576	09974	06862	03242-	09958	09902
3230	80	166 34	611	3	08197	09137	06724	04732-	09106	09074
3230	80	166 34	611	4	09640	08692	07363	06290-	08640	08621
3230	60	166 34	611	5	11287	08938	07561	08478-	08842	08861
3230	90	166 34	611	1	08920	09630	08754	01739	09625	09517
3230	90	166 34	611	2	06888	09295	05586	04056-	09271	09251
3230	90	166 34	611	3	07227	08800	04963	05280-	08762	08767
3230	90	166 34	611	4	08574	08429	05285	06790-	08370	08393
3230	90	166 34	611	5	10502	08641	06033	08659-	08543	08594
3240	00	166 34	000	1	05007	05724	04834	01312	05722	05703
3240	00	166 34	000	2	02783	06523	01407	02402-	06517	06521
3240	00	166 34	000	3	04055	06484	00949	03943-	06468	06483
3240	00	166 34	000	4	06566	06595	01191	06458-	06553	06593
3240	00	166 34	000	5	08205	07490	02352	07869-	07419	07483

PART c: Distance behind duct exit = 1.62 inches; β = 18 degrees

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_τ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3211	00	166 34	203	1	05442	10950	05441	00135	10949	10900
3211	00	166 34	203	2	04872	12084	04111	02622-	12071	12052
3211	00	166 34	203	3	05949	11747	03724	04652-	11708	11722
3211	00	166 34	203	4	08157	11606	04382	06907-	11522	11572
3211	00	166 34	203	5	10251	11606	04665	09168-	11458	11568
3211	20	166 34	203	1	05368	10399	05363	00226-	10398	10353
3211	20	166 34	203	2	04524	11660	03929	02250-	11651	11632
3211	20	166 34	203	3	05506	11326	03345	04383-	11292	11306
3211	20	166 34	203	4	07101	11045	03591	06142-	10981	11023
3211	20	166 34	203	5	09304	11129	03903	08472-	11008	11103
3211	40	166 34	203	1	05173	10388	05161	00340-	10387	10345
3211	40	166 34	203	2	03971	11363	03273	02255-	11356	11344
3211	40	166 34	203	3	04974	10821	02735	04160-	10792	10808
3211	40	166 34	203	4	07025	10706	03358	06184-	10643	10687
3211	40	166 34	203	5	09160	10918	03648	08425-	10800	10896
3211	60	166 34	203	1	04907	10007	04905	00127	10007	09970
3211	60	166 34	203	2	03469	11151	02672	02216-	11142	11138
3211	60	166 34	203	3	04617	10863	02032	04149-	10834	10856
3211	60	166 34	203	4	06822	10664	02716	06267-	10600	10652
3211	60	166 34	203	5	08617	10875	03251	07997-	10769	10857
3211	80	166 34	203	1	04373	09785	04179	01294	09782	09759
3211	80	166 34	203	2	03168	10982	01754	02640-	10970	10976
3211	80	166 34	203	3	04597	10653	01678	04282-	10623	10648
3211	60	166 34	203	4	06824	10537	02382	06402-	10471	10528
3211	60	166 34	203	5	08662	10918	02784	08215-	10806	10905
3221	00	166 34	407	1	09410	13544	09311	01387-	13540	13365

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART C (continued)

Code No.	α deg	∅ deg-min	V ft/sec	Tube No.	i_σ deg	q_o lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3221	00	166 34	407	2	08897	14211	08246	03388-	14186	14064
3221	00	166 34	407	3	10417	12962	09082	05187-	12910	12800
3221	00	166 34	407	4	11860	12211	09718	06930-	12124	12038
3221	00	166 34	407	5	14279	10860	09501	10854-	10670	10716
3221	20	166 34	407	1	08743	13275	08490	02119-	13266	13129
3221	20	166 34	407	2	08526	13787	08174	02455-	13774	13647
3221	20	166 34	407	3	09797	12793	08764	04448-	12755	12644
3221	20	166 34	407	4	11323	11987	09408	06413-	11913	11827
3221	20	166 34	407	5	13198	11168	08762	10006-	11001	11040
3221	40	166 34	407	1	08354	12509	08312	00850-	12507	12377
3221	40	166 34	407	2	07072	13066	06598	02568-	13053	12979
3221	40	166 34	407	3	07969	12288	06876	04066-	12257	12200
3221	40	166 34	407	4	09332	11993	07195	06005-	11928	11899
3221	40	166 34	407	5	11377	11600	07300	08819-	11464	11508
3221	60	166 34	407	1	07662	12296	07660	00197	12295	12186
3221	60	166 34	407	2	05987	12684	05397	02606-	12671	12627
3221	60	166 34	407	3	06723	12288	05440	03974-	12258	12232
3221	60	166 34	407	4	08673	11516	06166	06145-	11450	11450
3221	60	166 34	407	5	10329	11558	06061	08425-	11434	11494
3221	80	166 34	407	1	06060	11720	06015	00742	11719	11655
3221	80	166 34	407	2	04993	12417	04312	02527-	12404	12381
3221	80	166 34	407	3	06049	11826	04221	04348-	11792	11794
3221	80	166 34	407	4	07826	11293	04621	06343-	11224	11256
3221	80	166 34	407	5	09665	11631	04905	08369-	11507	11589
3231	00	166 34	615	1	16708	16647	15875	05485-	16576	16017
3231	00	166 34	615	2	15526	16074	15280	02883-	16055	15507
3231	00	166 34	615	3	16566	12975	15948	04723-	12934	12478
3231	00	166 34	615	4	16854	11363	15605	06694-	11291	10949
3231	00	166 34	615	5	16443	09362	13940	09070-	09251	09092
3231	10	166 34	615	1	16186	16229	15291	05569-	16157	15659
3231	10	166 34	615	2	14992	16026	14769	02695-	16009	15497
3231	10	166 34	615	3	15737	13294	15134	04524-	13255	12835
3231	10	166 34	615	4	15933	11935	14705	06409-	11865	11548
3231	10	166 34	615	5	15277	10417	12811	08604-	10305	10163
3231	20	166 34	615	1	14785	15840	14288	03967-	15804	15352
3231	20	166 34	615	2	13499	15920	13229	02787-	15902	15498
3231	20	166 34	615	3	14148	13724	13437	04595-	13682	13350
3231	20	166 34	615	4	14392	12914	12982	06431-	12836	12587
3231	20	166 34	615	5	14916	11559	11725	09480-	11407	11324
3231	30	166 34	615	1	12772	15297	12682	01566-	15291	14924
3231	30	166 34	615	2	11571	15618	11122	03273-	15593	15325
3231	30	166 34	615	3	12312	13782	11312	04988-	13731	13516
3231	30	166 34	615	4	12905	13521	11073	06795-	13429	13272
3231	30	166 34	615	5	14737	12442	10709	10360-	12245	12232
3231	40	166 34	616	1	11108	14658	11108	00063	14657	14383
3231	40	166 34	616	2	09452	15221	08841	03398-	15194	15040

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART c (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3231	40	166 34	616	3	10143	13880	09006	04743-	13833	13710
3231	40	166 34	616	4	11229	13552	09287	06425-	13469	13376
3231	40	166 34	616	5	12862	13101	08810	09519-	12924	12950
3231	50	166 34	616	1	11608	14573	11608	00048	14573	14274
3231	50	166 34	616	2	09166	15094	08556	03338-	15068	14926
3231	50	166 34	616	3	09651	13923	08447	04735-	13676	13772
3231	50	166 34	616	4	10554	13496	08520	06320-	13415	13348
3231	50	166 34	616	5	12169	13046	08212	09103-	12884	12915
3231	60	166 34	616	1	09954	14728	09952	00234-	14727	14506
3231	60	166 34	616	2	08367	15137	07831	02983-	15116	14996
3231	60	166 34	616	3	08977	13965	07718	04642-	13920	13839
3231	60	166 34	616	4	10076	13483	07988	06220-	13405	13353
3231	60	166 34	616	5	11600	13088	07751	08735-	12938	12971
3231	70	166 34	616	1	08478	14714	08476	00144-	14714	14553
3231	70	166 34	616	2	07587	15094	07038	02861-	15075	14980
3231	70	166 34	616	3	08470	13796	07043	04752-	13749	13692
3231	70	166 34	616	4	09804	13215	07406	06495-	13131	13106
3231	70	166 34	616	5	11143	13075	07152	08632-	12929	12975
3231	80	166 34	616	1	07565	14657	07560	00282	14656	14529
3231	80	166 34	616	2	07009	14882	06269	03160-	14859	14793
3231	80	166 34	616	3	07685	13586	06052	04771-	13539	13510
3231	80	166 34	616	4	09236	13131	06398	06716-	13041	13050
3231	80	166 34	616	5	10620	12906	06512	08460-	12767	12824
3231	90	166 34	616	1	07017	14062	06880	01397	14057	13960
3231	90	166 34	616	2	06087	14289	04956	03551-	14261	14235
3231	90	166 34	616	3	06899	13249	04442	05299-	13192	13209
3231	90	166 34	616	4	08439	12906	04954	06865-	12814	12858
3231	90	166 34	616	5	10167	12893	05499	08604-	12749	12835
3241	00	166 34	000	1	05097	09107	04419	02549	09097	09079
3241	00	166 34	000	2	03042	10462	01098	02838-	10449	10460
3241	00	166 34	000	3	04651	10221	01030	04536-	10188	10219
3241	00	166 34	000	4	06609	10262	01255	06491-	10196	10259
3241	00	166 34	000	5	08378	10610	02115	08114-	10503	10602
3291	00	089 40	204	1	07536	10493	06475-	03889-	10469	10426
3291	00	089 40	204	2	08467	11490	07914	03049-	11474	11380
3291	00	089 40	204	3	10408	10137	09511	04305-	10109	09998
3291	00	089 40	204	4	13252	09222	11836	06132-	09171	09028
3291	00	089 40	204	5	14310	08386	12606	06996-	08326	08186
3291	20	089 40	204	1	08440	09823	07055-	04681-	09790	09749
3291	20	089 40	204	2	08423	11066	08202	01947-	11059	10952
3291	20	089 40	204	3	09377	10011	08884	03048-	09997	09891
3291	20	089 40	204	4	11827	09185	10947	04589-	09156	09018
3291	20	089 40	204	5	12869	08268	11638	05645-	08229	08099
3291	40	089 40	204	1	07308	09091	05982-	04229-	09066	09041
3291	40	089 40	204	2	07175	10260	07095	01078-	10258	10181
3291	40	089 40	204	3	07605	09632	07353	01963-	09626	09552

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.
2. Negative values in the table are followed by a negative sign.

TABLE 8

PART c (continued)

Code No.	a deg	∅ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft²	i_α deg	i_β deg	q_σ lb/ft²	q_β lb/ft²
3291	40	089 40	204	4	09473	08937	08824	03500-	08920	08831
3291	40	089 40	204	5	10793	08040	09663	04901-	08011	07926
3291	60	089 40	204	1	04733	08429	03266-	03432-	08413	08415
3291	60	089 40	204	2	04906	10166	04905	00123-	10165	10128
3291	60	089 40	204	3	05113	09464	04990	01122-	09462	09428
3291	60	089 40	204	4	07019	08539	06377	02957-	08527	08486
3291	60	089 40	204	5	08109	07981	07164	03839-	07963	07918
3291	80	089 40	204	1	02023	08032	00115-	02020-	08026	08031
3291	80	089 40	204	2	02751	09902	02741	00235	09901	09890
3291	80	089 40	204	3	02791	09338	02754	00453-	09337	09327
3291	80	089 40	204	4	03724	08522	03255	01812-	08517	08508
3291	80	089 40	204	5	04932	07889	04045	02830-	07879	07869
3301	00	089 40	407	1	99999	99999	99999	99999	99999	99999
3301	00	089 40	407	2	99999	99999	99999	99999	99999	99999
3301	00	089 40	407	3	21648	11803	20813	06513-	11736	11041
3301	00	089 40	407	4	22669	10395	21431	08127-	10304	09689
3301	00	089 40	407	5	24025	09095	22671	08846-	09002	08407
3301	20	089 40	407	1	20914	13869	15309-	14930-	13431	13407
3301	20	089 40	407	2	20980	13057	19438	08532-	12928	12327
3301	20	089 40	407	3	21600	11441	20547	07270-	11360	10723
3301	20	089 40	407	4	23302	10811	22162	07970-	10721	10025
3301	20	089 40	407	5	24591	09448	23504	08109-	09368	08677
3301	40	089 40	407	1	13415	11729	11247-	07501-	11632	11507
3301	40	089 40	407	2	14324	12241	13700	04347-	12207	11894
3301	40	089 40	407	3	15544	10982	14825	04886-	10944	10618
3301	40	089 40	407	4	18108	09998	17160	06143-	09945	09557
3301	40	089 40	407	5	18189	09177	17142	06458-	09123	08774
3301	60	089 40	407	1	07806	10249	05817-	05241-	10206	10196
3301	60	089 40	407	2	08656	11193	08512	01598-	11188	11069
3301	60	089 40	407	3	09921	10305	09650	02346-	10296	10159
3301	60	089 40	407	4	11872	09526	11214	03997-	09503	09344
3301	60	089 40	407	5	12082	08683	11333	04299-	08659	08514
3301	80	089 40	407	1	02740	08623	00431	02706-	08613	08622
3301	80	089 40	407	2	03227	10420	03203	00395	10419	10403
3301	80	089 40	407	3	04054	09800	04042	00322-	09799	09775
3301	80	089 40	407	4	05360	09079	04958	02047-	09073	09045
3301	80	089 40	407	5	05651	08480	04793	03007-	08468	08450
3311	00	089 40	611	1	99999	99999	99999	99999	99999	99999
3311	00	089 40	611	2	99999	99999	99999	99999	99999	99999
3311	00	089 40	611	3	99999	99999	99999	99999	99999	99999
3311	00	089 40	611	4	99999	99999	99999	99999	99999	99999
3311	00	089 40	611	5	99999	99999	99999	99999	99999	99999
3311	10	089 40	611	1	99999	99999	99999	99999	99999	99999
3311	10	089 40	611	2	99999	99999	99999	99999	99999	99999
3311	10	089 40	611	3	99999	99999	99999	99999	99999	99999
3311	10	089 40	611	4	99999	99999	99999	99999	99999	99999

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART c (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3311	10	089 40	611	5	99999	99999	99999	99999	99999	99999
3311	20	089 40	611	1	99999	99999	99999	99999	99999	99999
3311	20	089 40	611	2	99999	99999	99999	99999	99999	99999
3311	20	089 40	611	3	99999	99999	99999	99999	99999	99999
3311	20	089 40	611	4	99999	99999	99999	99999	99999	99999
3311	20	089 40	611	5	99999	99999	99999	99999	99999	99999
3311	30	089 40	611	1	21292	14882	18080-	12016-	14586	14176
3311	30	089 40	611	2	24042	14766	22740	08689-	14621	13641
3311	30	089 40	611	3	24788	12948	23608	08483-	12828	11884
3311	30	089 40	611	4	27021	12449	25822	09146-	12320	11232
3311	30	089 40	611	5	99999	99999	99999	99999	99999	99999
3311	40	089 40	613	1	15496	13491	13584-	07742-	13374	13120
3311	40	089 40	613	2	17358	13807	16700	05012-	13758	13228
3311	40	089 40	613	3	18622	12439	17893	05513-	12386	11842
3311	40	089 40	613	4	20655	11539	19725	06638-	11470	10870
3311	40	089 40	613	5	21361	10506	20540	06399-	10448	09845
3311	50	089 40	613	1	11381	12684	09979-	05582-	12625	12493
3311	50	089 40	613	2	13947	13238	13553	03420-	13215	12870
3311	50	089 40	613	3	15261	12022	14719	04215-	11991	11629
3311	50	089 40	613	4	16859	11177	16135	05157-	11135	10740
3311	50	089 40	613	5	17179	10261	16391	05438-	10218	09847
3311	60	089 40	613	1	08410	11895	07283-	04250-	11862	11799
3311	60	089 40	613	2	11139	12664	10959	02045-	12656	12433
3311	60	089 40	613	3	12156	11789	11787	03059-	11772	11541
3311	60	089 40	613	4	13990	11036	13415	04119-	11009	10736
3311	60	089 40	613	5	14146	10025	13509	04357-	09997	09749
3311	70	089 40	613	1	05836	11309	04835-	03283-	11290	11268
3311	70	089 40	613	2	08702	12113	08681	00612-	12112	11974
3311	70	089 40	613	3	09498	11429	09359	01646-	11424	11277
3311	70	089 40	613	4	11180	10610	10751	03141-	10594	10424
3311	70	089 40	613	5	11479	09647	10869	03780-	09626	09474
3311	80	089 40	613	1	05008	10578	03742-	03338-	10560	10555
3311	80	089 40	613	2	06557	11775	06556	00123	11774	11697
3311	80	089 40	613	3	07116	11177	07020	01177-	11174	11093
3311	80	089 40	613	4	08371	10314	07987	02537-	10306	10214
3311	80	089 40	613	5	08047	09618	07453	03069-	09604	09536
3311	90	089 40	613	1	03857	10568	00124	03855-	10544	10567
3311	90	089 40	613	2	03293	11721	03249	00531-	11720	11702
3311	90	089 40	613	3	04109	11009	03812	01538-	11005	10984
3311	90	089 40	613	4	05153	10030	04322	02816-	10017	10001
3311	90	089 40	613	5	05143	09440	04055	03173-	09425	09610
3321	00	089 40	000	1	04725	07828	03867	02723-	07819	07810
3321	00	089 40	000	2	00975	09722	00805	00551	09721	09720
3321	00	089 40	000	3	01766	08992	01710	00439-	08991	08981
3321	00	089 40	000	4	02485	08336	01673	01838-	08331	08337
3321	00	089 40	000	5	02597	07747	01571	02069-	07741	07746

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART c (continued)

Code No.	α deg	ø deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_α lb/ft^2	q_β lb/ft^2
3371	00	008 26	203	1	23679	00091	23127	05682-	00090	00083
3371	00	008 26	203	2	10209	01313	08159-	06219-	01305	01299
3371	00	008 26	203	3	05147	10252	03919	03346-	10234	10228
3371	00	008 26	203	4	07877	10092	03955	06833-	10020	10068
3371	00	008 26	203	5	08770	11106	02210	08495-	10984	11097
3371	20	008 26	203	1	12390	00170	11877	03632-	00169	00166
3371	20	008 26	203	2	05638	05718	00117-	05637-	05690	05717
3371	20	008 26	203	3	06712	10084	03982	05420-	10039	10059
3371	20	008 26	203	4	07925	10272	03745	07004-	10195	10250
3371	20	008 26	203	5	08348	11317	01882	08139-	11203	11310
3371	40	008 26	203	1	04803	04400	03925-	02777-	04394	04389
3371	40	008 26	203	2	05289	10324	02943	04403-	10293	10310
3371	40	008 26	203	3	06825	10588	03490	05880-	10532	10568
3371	40	008 26	203	4	07248	10768	02865	06668-	10695	10754
3371	40	008 26	203	5	07524	11264	01086	07446-	11169	11262
3371	60	008 26	203	1	04704	05797	04047-	02405-	05791	05782
3371	60	008 26	203	2	05438	10663	02266	04949-	10623	10654
3371	60	008 26	203	3	06507	10757	02255	06110-	10695	10748
3371	60	008 26	203	4	06854	10768	01704	06643-	10695	10763
3371	60	008 26	203	5	07418	11095	00244	07414-	11002	11094
3371	80	008 26	203	1	05449	07412	04506-	03077-	07401	07389
3371	80	008 26	203	2	04572	10917	00300	04562-	10882	10916
3371	80	008 26	203	3	05918	10757	00429	05903-	10699	10756
3371	80	008 26	203	4	06660	10768	00052	06660-	10695	10768
3371	80	008 26	203	5	07563	10673	01165-	07475-	10582	10670
3381	00	008 26	409	1	99999	99999	99999	99999	99999	99999
3381	00	008 26	409	2	99999	99999	99999	99999	99999	99999
3381	00	008 26	409	3	99999	99999	99999	99999	99999	99999
3381	00	008 26	409	4	07432	02280	07377-	00908-	02279	02261
3381	00	008 26	409	5	04806	07586	00000	04806-	07559	07586
3381	20	008 26	409	1	99999	99999	99999	99999	99999	99999
3381	20	008 26	409	2	99999	99999	99999	99999	99999	99999
3381	20	008 26	409	3	05428	00378	04623	02857-	00377	00376
3381	20	008 26	409	4	05241	05104	04981	01639-	05101	05084
3381	20	008 26	409	5	06831	09281	04678	04999-	09245	09250
3381	40	008 26	409	1	02582	02238	00439-	02545	02235	02237
3381	40	008 26	409	2	08073	10334	06841	04327-	10304	10260
3381	40	008 26	409	3	09823	10630	07596	06301-	10566	10537
3381	40	008 26	409	4	09784	11255	06659	07233-	11166	11180
3381	40	008 26	409	5	08976	11908	04260	07930-	11794	11875
3381	60	008 26	409	1	02608	05996	02599-	00205-	05995	05989
3381	60	008 26	409	2	06680	11224	04405	05041-	11180	11191
3381	60	008 26	409	3	07971	11219	04681	06479-	11147	11182
3381	60	008 26	409	4	08058	11540	03719	07168-	11450	11516
3381	60	008 26	409	5	08009	12023	01817	07805-	11911	12017
3381	60	008 26	409	1	04158	08285	03667-	01964-	08280	08267

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART c (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3381	80	008 26	409	2	05203	11763	01634	04942-	11719	11758
3381	80	008 26	409	3	06129	11639	01534	05937-	11576	11634
3381	80	008 26	409	4	06884	11571	00959	06818-	11489	11569
3381	80	008 26	409	5	07571	11643	00545-	07552-	11541	11642
3391	00	008 26	614	1	99999	99999	99999	99999	99999	99999
3391	00	008 26	614	2	99999	99999	99999	99999	99999	99999
3391	00	008 26	614	3	15539	00297	14637	05450	00295	00287
3391	00	008 26	614	4	99999	99999	99999	99999	99999	99999
3391	00	008 26	614	5	04771	01180	03422	03332-	01178	01177
3391	10	008 26	614	1	99999	99999	99999	99999	99999	99999
3391	10	008 26	614	2	99999	99999	99999	99999	99999	99999
3391	10	008 26	614	3	99999	99999	99999	99999	99999	99999
3391	10	008 26	614	4	99999	99999	99999	99999	99999	99999
3391	10	008 26	614	5	03342	01894	00129-	03339-	01890	01893
3391	20	008 26	614	1	99999	99999	99999	99999	99999	99999
3391	20	008 26	614	2	99999	99999	99999	99999	99999	99999
3391	20	008 26	614	3	99999	99999	99999	99999	99999	99999
3391	20	008 26	614	4	12928	01022	06224	11419-	01001	01016
3391	20	008 26	614	5	08557	07812	08043	02961-	07801	07735
3391	30	008 26	614	1	99999	99999	99999	99999	99999	99999
3391	30	008 26	614	2	99999	99999	99999	99999	99999	99999
3391	30	008 26	614	3	15864	05453	14414	06913-	05415	05283
3391	30	008 26	614	4	15597	08105	13773	07609-	08037	07875
3391	30	008 26	614	5	12100	11170	09253	07935-	11065	11027
3391	40	008 26	616	1	16084	01454	06340	14899	01405	01445
3391	40	008 26	616	2	10638	11224	09464	04965-	11103	11072
3391	40	008 26	616	3	12846	11590	10696	07282-	11499	11391
3391	40	008 26	616	4	12491	12216	09540	08212-	12094	12050
3391	40	008 26	616	5	10247	13527	05827	08687-	13380	13458
3391	50	008 26	616	1	07459	03225	00445-	07446	03197	03224
3391	50	008 26	616	2	09876	11859	08380	05302-	11809	11733
3391	50	008 26	616	3	11446	11903	09011	07174-	11812	11758
3391	50	008 26	616	4	11083	12465	07827	07945-	12347	12351
3391	50	008 26	616	5	09676	13344	04811	08434-	13200	13297
3391	60	008 26	616	1	03139	06334	01204-	02900	06325	06332
3391	60	008 26	616	2	08212	12325	06193	05435-	12270	12253
3391	60	008 26	616	3	09166	12521	06025	06957-	12429	12452
3391	60	008 26	616	4	09247	12778	05210	07681-	12664	12726
3391	60	008 26	616	5	08609	13471	02602	08217-	13333	13457
3391	70	008 26	616	1	02455	07981	02055-	01343	07978	07975
3391	70	008 26	616	2	06875	12664	04023	05594-	12604	12633
3391	70	008 26	616	3	07584	12647	03948	06496-	12566	12617
3391	70	008 26	616	4	07953	12893	03088	07343-	12787	12874
3391	70	008 26	616	5	08185	13260	01043	08129-	13127	13257
3391	80	008 26	616	1	02971	08699	02611-	01418	08696	08690
3391	80	008 26	616	2	06195	12961	02648	05606-	12899	12947

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8 PART d

Code No.	α deg	β deg-min		V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3391	80	008	26	616	3	06750	13026	02375	06325-	12946	13014
3391	80	008	26	616	4	07622	12795	01713	07431-	12687	12789
3391	80	008	26	616	5	07995	13289	00012	07995-	13159	13289
3391	90	008	26	616	1	05486	10292	05454-	00598	10291	10245
3391	90	008	26	616	2	05615	13257	00328-	05606-	13193	13256
3391	90	008	26	616	3	06311	12942	00625-	06281-	12864	12941
3391	90	008	26	616	4	06864	12837	00980-	06795-	12746	12835
3391	90	008	26	616	5	08291	12753	02442-	07932-	12631	12741
3401	00	008	26	000	1	06145	07886	05270-	03178-	07873	07852
3401	00	008	26	000	2	05284	10790	01101-	05169-	10746	10788
3401	00	008	26	000	3	05908	10588	00986-	05826-	10533	10586
3401	00	008	26	000	4	06428	10673	01444-	06266-	10609	10669
3401	00	008	26	000	5	07768	10462	02407-	07394-	10375	10452

PART d: Distance behind duct exit = 5.50 inches; β = 18 degrees

3161	00	008	16	205	1	99999	99999	99999	99999	99999	99999
3161	00	008	16	205	2	16773	00172	15493	06748-	00170	00165
3161	00	008	16	205	3	07305	04423	06330	03675	04413	04396
3161	00	008	16	205	4	10304	08111	09655	03666	08094	07996
3161	00	008	16	205	5	09097	08129	08659	02832	08119	08036
3161	20	008	16	205	1	99999	99999	99999	99999	99999	99999
3161	20	008	16	205	2	04676	01739	03718	02844	01736	01735
3161	20	008	16	205	3	09490	07541	09147	02571	07533	07445
3161	20	008	16	205	4	08960	08137	08596	02565	08129	08045
3161	20	008	16	205	5	08047	08036	07568	02767	08026	07966
3161	40	008	16	205	1	02499	01397	01078	02255-	01395	01396
3161	40	008	16	205	2	07804	08281	07365	02609	08272	08212
3161	40	008	16	205	3	07224	08762	06756	02581	08753	08701
3161	40	008	16	205	4	05876	08332	05127	02885	08321	08298
3161	40	008	16	205	5	05863	08155	04860	03295	08141	08125
3161	60	008	16	205	1	01228	02585	00769-	00958-	02584	0258[illegible]
3161	60	008	16	205	2	05947	09640	05533	02193	09633	09595
3161	60	008	16	205	3	04838	09099	04128	02532	09090	09075
3161	60	008	16	205	4	04069	08493	02924	02834	08482	08481
3161	60	008	16	205	5	04678	08155	02766	03778	08137	08145
3161	80	008	16	205	1	02779	04361	00713-	02686-	04356	04360
3161	80	008	16	205	2	04279	09715	03687	02178	09708	09694
3161	80	008	16	205	3	03276	09184	02105	02512	09175	09177
3161	80	008	16	205	4	03159	08442	01014	02992	08430	08440
3161	80	008	16	205	5	04295	08113	01394	04064	08092	08110
3171	00	008	16	408	1	99999	99999	99999	99999	99999	99999
3171	00	008	16	408	2	99999	99999	99999	99999	99999	99999
3171	00	008	16	408	3	99999	99999	99999	99999	99999	99999
3171	00	008	16	408	4	19589	01031	02953	19397-	00972	01029
3171	00	008	16	408	5	11145	03515	09457	06005	03496	03467
3171	20	008	16	408	1	99999	99999	99999	99999	99999	99999
3171	20	008	16	408	2	99999	99999	99999	99999	99999	99999
3171	20	008	16	408	3	99999	99999	99999	99999	99999	99999

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART 3 (continued)

Code No.	α deg	ϕ deg-min		V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_c $\frac{lb}{ft^2}$	i_a deg	i_β deg	q_J $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3171	20	008	16	408	4	14675	01203	13513	05940-	01196	01169
3171	20	008	16	408	5	14338	05497	13383	05337	05474	05348
3171	40	008	16	408	1	99999	99999	99999	99999	99999	99999
3171	40	008	16	408	2	13368	03661	13302	01371	03660	03562
3171	40	008	16	408	3	14551	05984	14459	01711	05981	05794
3171	40	008	16	408	4	13157	06966	13031	01878	06962	06786
3171	40	008	16	408	5	11946	08183	11560	03094	08171	08017
3171	60	008	16	408	1	10872	01706	10353	03391	01703	01678
3171	60	008	16	408	2	10078	08616	09921	01811	08611	08487
3171	60	008	16	408	3	09215	09095	08920	02352	09087	08985
3171	60	008	16	408	4	07642	08717	07209	02561	08708	08648
3171	60	008	16	408	5	07692	08666	07061	03082	08653	08600
3171	80	008	16	408	1	03813	04278	03637	01146-	04277	04269
3171	80	008	16	408	2	05885	10144	05481	02157	10136	10097
3171	80	008	16	408	3	04736	09516	03957	02610	09506	09493
3171	80	008	16	408	4	04363	08911	02881	03281	08896	08899
3171	80	008	16	408	5	04995	08531	02912	04065	08509	08519
3181	00	008	16	615	1	99999	99999	99999	99999	99999	99999
3181	00	008	16	615	2	99999	99999	99999	99999	99999	99999
3181	00	008	16	615	3	99999	99999	99999	99999	99999	99999
3181	00	008	16	615	4	99999	99999	99999	99999	99999	99999
3181	00	008	16	615	5	02399	00000	02314-	00633	00000	00000
3181	10	008	16	615	1	99999	99999	99999	99999	99999	99999
3181	10	008	16	615	2	99999	99999	99999	99999	99999	99999
3181	10	008	16	615	3	99999	99999	99999	99999	99999	99999
3181	10	008	16	615	4	99999	99999	99999	99999	99999	99999
3181	10	008	16	615	5	99999	99999	99999	99999	99999	99999
3181	20	008	16	615	1	99999	99999	99999	99999	99999	99999
3181	20	008	16	615	2	99999	99999	99999	99999	99999	99999
3181	20	008	16	615	3	99999	99999	99999	99999	99999	99999
3181	20	008	16	615	4	99999	99999	99999	99999	99999	99999
3181	20	008	16	615	5	16587	02065	13583	09882-	02035	02008
3181	30	008	16	615	1	99999	99999	99999	99999	99999	99999
3181	30	008	16	615	2	99999	99999	99999	99999	99999	99999
3181	30	008	16	615	3	99999	99999	99999	99999	99999	99999
3181	30	008	16	615	4	27086	03433	26908	03606-	03427	03062
3181	30	008	16	615	5	20350	06014	20349	00189-	06013	05638
3181	40	008	16	615	1	99999	99999	99999	99999	99999	99999
3181	40	008	16	615	2	25763	02842	25537	03901-	02836	02565
3181	40	008	16	615	3	21094	06150	21093	00156	06149	05737
3181	40	008	16	615	4	19616	07265	19613	00371	07264	06863
3181	40	008	16	615	5	16620	08478	16570	01354	08475	08126
3181	50	008	16	615	1	23073	02640	22313	06514	02625	02464
3181	50	008	16	616	2	13267	09067	13249	00731	09066	08825
3181	50	008	16	616	3	13886	10208	13762	01925	10202	09915
3181	50	008	16	616	4	12363	09673	12080	02707	09662	09459

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART d (continued)

Code No.	α deg	φ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3181	50	008 16	616	5	10250	09997	09853	02881	09984	09849
3181	60	008 16	616	1	19637	00393	19029	05227	00391	00371
3181	60	008 16	616	2	11760	09941	11667	01518	09937	09735
3181	60	008 16	616	3	11875	10336	11673	02241	10328	10122
3181	60	008 16	616	4	10217	09804	09853	02758	09792	09659
3181	60	008 16	616	5	08428	10071	07925	02907	10058	09975
3181	70	008 16	616	1	10845	03966	10665	02011	03963	03897
3181	70	008 16	616	2	09593	10696	09406	01917	10690	10552
3181	70	008 15	616	3	08464	10526	08135	02371	10517	10420
3181	70	008 16	616	4	07270	09944	06738	02753	09932	09875
3181	70	008 16	616	5	06706	09850	05859	03285	09833	09798
3181	80	008 16	616	1	06502	05438	06461	00736-	05437	05403
3181	80	008 16	616	2	07020	11205	06710	02081	11197	11128
3181	80	008 16	616	3	05461	10779	04795	02625	10767	10741
3181	80	008 16	616	4	05011	09713	03882	03178	09698	09690
3181	80	008 16	616	5	05359	09671	03789	03800	09649	09649
3181	90	008 16	616	1	03981	06608	03765	01297-	06606	06593
3181	90	008 16	616	2	04931	11448	04571	01857	11442	11411
3181	90	008 16	616	3	03316	10863	02348	02344	10853	10853
3181	90	008 16	616	4	03542	09882	01398	03256	09866	09879
3181	90	008 16	616	5	04360	09291	01444	04116	09267	09288
3191	00	008 16	000	1	05675	05772	01292-	05528-	05745	05770
3191	00	008 16	000	2	01973	09531	00890	01761	09526	09529
3191	00	008 16	000	3	02487	09010	00345-	02462	09001	09009
3191	00	008 16	000	4	03843	08235	01687-	03455	08220	08231
3191	00	008 16	000	5	04568	07517	01474-	04326	07495	07514
3081	00	089 40	204	1	20305	11375	05851-	19572-	10723	11322
3081	00	089 40	204	2	13870	11079	08744	10933-	10882	10954
3081	00	089 40	204	3	13993	09658	10693	09236-	09536	09494
3081	00	089 40	204	4	15432	08934	12983	08632-	08837	08710
3081	00	089 40	204	5	14608	07933	13186	06514-	07884	07726
3081	20	089 40	204	1	12573	09597	06910-	10605-	09435	09529
3081	20	089 40	204	2	10485	10908	08515	06208-	10845	10789
3081	20	089 40	204	3	11168	09820	09622	05778-	09771	09683
3081	20	089 40	204	4	12781	09137	11145	06417-	09081	08966
3081	20	089 40	204	5	13130	08072	12054	05362-	08038	07895
3081	40	089 40	204	1	09764	08650	07413-	06426-	08596	08578
3081	40	089 40	204	2	08084	10526	07484	03092-	10510	10436
3081	40	089 40	204	3	08424	09684	07735	03378-	09667	09596
3081	40	089 40	204	4	10552	08709	09744	04129-	08686	08583
3081	40	089 40	204	5	10383	08090	09861	03315-	08076	07970
3081	60	089 40	204	1	06467	08072	05031-	04083-	08051	08041
3081	60	089 40	204	2	05520	10049	05347	01399-	10045	10005
3081	60	089 40	204	3	05786	09558	05481	01864-	09553	09514
3081	60	089 40	204	4	07454	08675	06966	02679-	08665	08611
3081	60	089 40	204	5	07999	07821	07762	01956-	07816	07749

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.
2. Negative values in the table are followed by a negative sign.

TABLE C

PART d (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3081	80	089 40	204	1	03271	07786	01987-	02600-	07778	07781
3081	80	089 40	204	2	02835	10124	02829	00184-	10123	10111
3081	80	089 40	204	3	03420	09389	03382	00509-	09388	09372
3081	80	089 40	204	4	04187	08657	04049	01067-	08655	08635
3081	80	089 40	204	5	04691	07855	04649	00633-	07854	07829
3091	00	089 40	407	1	99999	99999	99999	99999	99999	99999
3091	00	089 40	407	2	99999	99999	99999	99999	99999	99999
3091	00	089 40	407	3	99999	99999	99999	99999	99999	99999
3091	00	089 40	407	4	99999	99999	99999	99999	99999	99999
3091	00	089 40	407	5	99999	99999	99999	99999	99999	99999
3091	20	089 40	407	1	99999	99999	99999	99999	99999	99999
3091	20	089 40	407	2	99999	99999	99999	99999	99999	99999
3091	20	089 40	407	3	99999	99999	99999	99999	99999	99999
3091	20	089 40	407	4	99999	99999	99999	99999	99999	99999
3091	20	089 40	407	5	99999	99999	99999	99999	99999	99999
3091	40	089 40	407	1	21003	09510	17414-	12484-	09304	09093
3091	40	089 40	407	2	20852	10468	18959	09343-	10343	09913
3091	40	089 40	407	3	19271	10130	17925	07558-	10050	09646
3091	40	089 40	407	4	21089	09617	19993	07286-	09548	09045
3091	40	089 40	407	5	21849	08554	21257	05547-	08519	07976
3091	60	089 40	407	1	12022	09763	10642-	05724-	09715	09596
3091	60	089 40	407	2	10781	10775	10266	03365-	10756	10603
3091	60	089 40	407	3	11281	10110	10826	03246-	10094	09930
3091	60	089 40	407	4	12797	09388	12250	03816-	09368	09175
3091	60	089 40	407	5	13271	08408	13048	02510-	08400	08191
3091	80	089 40	407	1	05659	08357	05339-	01886-	08352	08320
3091	80	089 40	407	2	04904	10764	04900	00208	10763	10724
3091	80	089 40	407	3	05690	10016	05671	00464-	10015	09966
3091	80	089 40	407	4	07105	09305	07003	01215-	09302	09235
3091	80	089 40	407	5	07247	08493	07240	00336-	08492	08425
3101	00	089 40	616	1	99999	99999	99999	99999	99999	99999
3101	00	089 40	616	2	99999	99999	99999	99999	99999	99999
3101	00	089 40	616	3	99999	99999	99999	99999	99999	99999
3101	00	089 40	616	4	99999	99999	99999	99999	99999	99999
3101	00	089 40	616	5	99999	99999	99999	99999	99999	99999
3101	10	089 40	616	1	99999	99999	99999	99999	99999	99999
3101	10	089 40	616	2	99999	99999	99999	99999	99999	99999
3101	10	089 40	616	3	99999	99999	99999	99999	99999	99999
3101	10	089 40	616	4	99999	99999	99999	99999	99999	99999
3101	10	089 40	616	5	99999	99999	99999	99999	99999	99999
3101	20	089 40	617	1	99999	99999	99999	99999	99999	99999
3101	20	089 40	617	2	99999	99999	99999	99999	99999	99999
3101	20	089 40	617	3	99999	99999	99999	99999	99999	99999
3101	20	089 40	617	4	99999	99999	99999	99999	99999	99999
3101	20	089 40	617	5	99999	99999	99999	99999	99999	99999
3101	30	089 40	617	1	99999	99999	99999	99999	99999	99999

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 2

PART d (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3101	30	089 40	617	2	99999	99999	99999	99999	99999	99999
3101	30	089 40	617	3	99999	99999	99999	99999	99999	99999
3101	30	089 40	617	4	99999	99999	99999	99999	99999	99999
3101	30	089 40	617	5	99999	99999	99999	99999	99999	99999
3101	40	089 40	617	1	26801	11976	23649-	14134-	11669	11023
3101	40	089 40	617	2	27959	13124	26254	11093-	12925	11812
3101	40	089 40	617	3	25756	11780	24458	09141-	11655	10746
3101	40	089 40	617	4	27657	11456	26672	08490-	11355	10259
3101	40	089 40	617	5	99999	99999	99999	99999	99999	99999
3101	50	089 40	617	1	20492	11699	18397-	09672-	11548	11116
3101	50	089 40	617	2	20587	12350	19458	07271-	12261	11654
3101	50	089 40	617	3	20086	11423	19078	06770-	11351	10803
3101	50	089 40	617	4	22057	10791	21171	06788-	10725	10071
3101	50	089 40	617	5	23424	09736	23096	04361-	09712	08959
3101	60	089 40	617	1	16968	11000	15781-	06559-	10933	10590
3101	60	089 40	617	2	14315	12162	13796	03971-	12134	11812
3101	60	089 40	617	3	14690	11550	14269	03643-	11528	11195
3101	60	089 40	617	4	16696	10575	16211	04217-	10548	10156
3101	60	089 40	617	5	17044	09404	16821	02910-	09392	09002
3101	70	089 40	617	1	13610	09730	13026-	04081-	09706	09480
3101	70	089 40	617	2	10150	12217	10062	01365-	12213	12029
3101	70	089 40	617	3	10976	11627	10862	01616-	11622	11418
3101	70	089 40	617	4	12789	10583	12574	02410-	10574	10329
3101	70	089 40	617	5	12805	09545	12756	01149-	09543	09309
3101	80	089 40	617	1	11418	08228	11342-	01345-	08225	08067
3101	80	089 40	617	2	07414	12175	07363	00877	12173	12074
3101	80	089 40	617	3	07979	11489	07979	00038	11488	11377
3101	80	089 40	617	4	09357	10383	09301	01045-	10381	10246
3101	80	089 40	617	5	09347	09601	09342	00323-	09600	09473
3101	90	089 40	617	1	04272	08467	04178-	00897-	08465	08444
3101	90	089 40	617	2	03839	11866	03732	00903	11864	11840
3101	90	089 40	617	3	04403	11194	04402	00107-	11193	11160
3101	90	089 40	617	4	05359	09971	05308	00741-	09970	09928
3101	90	089 40	617	5	04954	09455	04947	00262-	09454	09419
3111	00	089 40	000	1	05647	06533	04699	03145-	06523	06511
3111	00	089 40	000	2	00975	09907	00805	00551	09906	09906
3111	00	089 40	000	3	01462	09268	01426	00326-	09267	09265
3111	00	089 40	000	4	01715	08433	01537	00760-	08432	08429
3111	00	089 40	000	5	01670	07632	01639	00324-	07631	07628
3001	00	166 46	205	1	00506	10340	00490	00128	10339	10339
3001	00	166 46	205	2	02510	11007	00781	02385	10997	11005
3001	00	166 46	205	3	03912	09932	02176	03254	09915	09924
3001	00	166 46	205	4	04803	08991	02672	03997	08969	08981
3001	00	166 46	205	5	05518	07049	01206-	05386	07017	07047
3001	20	166 46	205	1	00523	09874	00439-	00283-	09873	09873
3001	20	166 46	205	2	03294	10595	00690	03221	10578	10594

General Notes:
1. The decimal location has been indicated by the vertical lines on the first page of this table.
2. Negative values in the table are followed by a negative sign.

TABLE 8

PART d (continued)

Code No.	α deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_α deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3001	20	166 46	205	3	04364	09721	01532	04088	09696	09717
3001	20	166 46	205	4	05313	06535	02095	04886	08504	08529
3001	20	166 46	205	5	05787	07598	00694-	05746	07559	07597
3001	40	166 46	205	1	01242	08044	00636-	01067-	08042	08043
3001	40	166 46	205	2	03404	10425	00428	03377	10406	10424
3001	40	166 46	205	3	04561	09469	01427	04333	09441	09466
3001	40	166 46	205	4	05442	08662	01722	05166	08626	08658
3001	40	166 46	205	5	05887	07598	00504-	05866	07558	07597
3001	60	166 46	205	1	01361	09483	00817-	01088-	09481	09482
3001	60	166 46	205	2	03482	10086	00301	03469	10067	10085
3001	60	166 46	205	3	04374	09258	01358	04159	09233	09255
3001	60	166 46	205	4	05333	08450	01517	05115	08416	08447
3001	60	166 46	205	5	05525	07471	00835-	05462	07437	07470
3001	80	166 46	205	1	01472	08966	01435-	00327	08965	08963
3001	80	166 46	205	2	03607	10044	00679-	03543	10024	10043
3001	80	166 46	205	3	04103	09090	00489	04074	09066	09089
3001	80	166 46	205	4	04889	08357	00985	04790	08327	08355
3001	80	166 46	205	5	05147	07513	00823-	05082	07483	07512
3011	00	166 46	410	1	06809	13340	06806	00178-	13339	13246
3011	00	166 46	410	2	08675	12126	08633	00864	12124	11988
3011	00	166 46	410	3	10807	09936	10684	01667	09931	09763
3011	00	166 46	410	4	11689	08420	11410	02606	08411	08253
3011	00	166 46	410	5	09998	03508	00840-	09964	03455	03507
3011	20	166 46	410	1	06334	12902	06294	00717-	12901	12824
3011	20	166 46	410	2	08106	12126	07958	01559	12121	12009
3011	20	166 46	410	3	09391	10179	09068	02483	10169	10051
3011	20	166 46	410	4	10171	08649	09400	03955	08628	08533
3011	20	166 46	410	5	07898	05110	00475-	07884	05061	05109
3011	40	166 46	410	1	04397	12144	04396	00113	12143	12108
3011	40	166 46	410	2	05053	11521	04595	02110	11513	11484
3011	40	166 46	410	3	06304	10263	05444	03198	10247	10216
3011	40	166 46	410	4	07397	09046	05736	04701	09015	09001
3011	40	166 46	410	5	06418	06968	00577	06392	06924	06967
3011	60	166 46	410	1	05242	11818	05184	00782-	11816	11769
3011	60	166 46	410	2	04837	11309	03848	02939	11294	11283
3011	60	166 46	410	3	05828	10179	04368	03873	10155	10149
3011	60	166 46	410	4	06607	09122	04241	05084	09086	09097
3011	60	166 46	410	5	06002	07601	01134	05895	07560	07599
3011	80	166 46	410	1	01299	10706	01286	00181	10705	10703
3011	80	166 46	410	2	03974	10886	02106	03373	10867	10878
3011	80	166 46	410	3	04881	09969	03040	03826	09946	09955
3011	80	166 46	410	4	05942	08995	03286	04962	08961	08980
3011	80	166 46	410	5	05780	07678	00885	05712	07639	07677
3021	00	166 46	618	1	24875	13780	23118	10253-	13099	12243
3021	00	166 46	618	2	23742	11499	23724	01042	11497	10527
3021	00	166 46	618	3	24417	08615	24411	00617	08614	07844

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART d (continued)

Code No.	α deg	ϕ deg-min	V ft/sec	Tube No.	i_σ deg	q_σ lb/ft^2	i_α deg	i_β deg	q_σ lb/ft^2	q_β lb/ft^2
3021	00	166 46	618	4	22369	05985	22258	02474	05980	05539
3021	00	166 46	618	5	99999	99999	99999	99999	99999	99999
3021	10	166 46	618	1	21374	13484	19975	08257-	13360	12688
3021	10	166 46	618	2	21098	11582	21065	01281	11579	10808
3021	10	166 46	618	3	21336	08773	21254	02053	08768	08176
3021	10	166 46	618	4	19132	07124	18760	04039	07108	06747
3021	10	166 46	618	5	15963	03127	03628	15585	03012	03121
3021	20	166 46	618	1	17317	14136	16616	05160-	14083	13550
3021	20	166 46	618	2	17437	12137	17429	00584	12136	11579
3021	20	166 46	618	3	17460	09610	17311	02421	09602	09175
3021	20	166 46	618	4	17159	07986	16627	04489	07963	07654
3021	20	166 46	618	5	12099	04911	02574	11837	04806	04906
3021	30	166 46	618	1	12905	14650	12800	01695-	14643	14286
3021	30	166 46	618	2	13096	12793	13093	00310-	12792	12460
3021	30	166 46	618	3	13127	10594	12986	01987	10587	10323
3021	30	166 46	618	4	13244	09004	12755	03684	08986	08782
3021	30	166 46	618	5	09405	05999	02182	09157	05922	05994
3021	40	166 46	621	1	08836	13700	08631	01916	13692	13545
3021	40	166 46	621	2	07252	12925	07251	00059	12925	12821
3021	40	166 46	621	3	08329	11477	08008	02317	11467	11365
3021	40	166 46	621	4	09179	09991	08095	04384	09962	09891
3021	40	166 46	621	5	07070	07597	02158	06739	07544	07591
3021	50	166 46	621	1	08135	14111	08085	00917	14109	13970
3021	50	166 46	621	2	06871	13433	06824	00805	13431	13337
3021	50	166 46	621	3	07989	11561	07579	02556	11549	11460
3021	50	166 46	621	4	08918	10150	07752	04462	10119	10057
3021	50	166 46	621	5	07055	07640	02466	06619	07589	07633
3021	60	166 46	621	1	07411	13205	07396	00468-	13204	13095
3021	60	166 46	621	2	07473	12798	07264	01771	12791	12695
3021	60	166 46	621	3	08402	11309	07717	03364	11289	11206
3021	60	166 46	621	4	09083	10076	07566	05085	10037	09988
3021	60	166 46	621	5	06908	07682	02283	06526	07632	07675
3021	70	166 46	621	1	05236	13420	05195	00658-	13419	13364
3021	70	166 46	621	2	06781	12798	06370	02345	12787	12719
3021	70	166 46	621	3	08224	11098	07347	03736	11074	11007
3021	70	166 46	621	4	09153	09949	07519	05279	09907	09864
3021	70	166 46	621	5	07138	07893	02660	06633	07840	07884
3021	80	166 46	621	1	04423	13111	04389	00550-	13110	13072
3021	80	166 46	621	2	05692	12671	05115	02508	12658	12620
3021	80	166 46	621	3	07099	11056	06081	03691	11033	10994
3021	80	166 46	621	4	08549	09727	06815	05211	09687	09658
3021	80	166 46	621	5	06891	08104	02775	06317	08054	08094
3021	90	166 46	621	1	03090	11957	02789	01332	11953	11942
3021	90	166 46	621	2	03758	12150	02776	02536	12138	12135
3021	90	166 46	621	3	05050	10804	03770	03369	10785	10780
3021	90	166 46	621	4	06769	09591	04478	05096	09553	09561

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

TABLE 8

PART d (continued)

Code No.	a deg	ϕ deg-min	V $\frac{ft}{sec}$	Tube No.	i_σ deg	q_σ $\frac{lb}{ft^2}$	i_a deg	i_β deg	q_σ $\frac{lb}{ft^2}$	q_β $\frac{lb}{ft^2}$
3021	90	166 46	621	5	06415	08188	01840	06149	08140	08183
3031	00	166 46	000	1	02137	07774	01345-	01661	07770	07771
3031	00	166 46	000	2	03727	09398	01496-	03415	09381	09394
3031	00	166 46	000	3	04060	08828	00001	04060	08805	08827
3031	00	166 46	000	4	04292	08222	00468	04267	08199	08221
3031	00	166 46	000	5	05105	07421	01143-	04977	07393	07419

General Notes: 1. The decimal location has been indicated by the vertical lines on the first page of this table.

2. Negative values in the table are followed by a negative sign.

FIGURES

FIGURE 1a: MODEL GENERAL ARRANGEMENT - SIDE VIEW

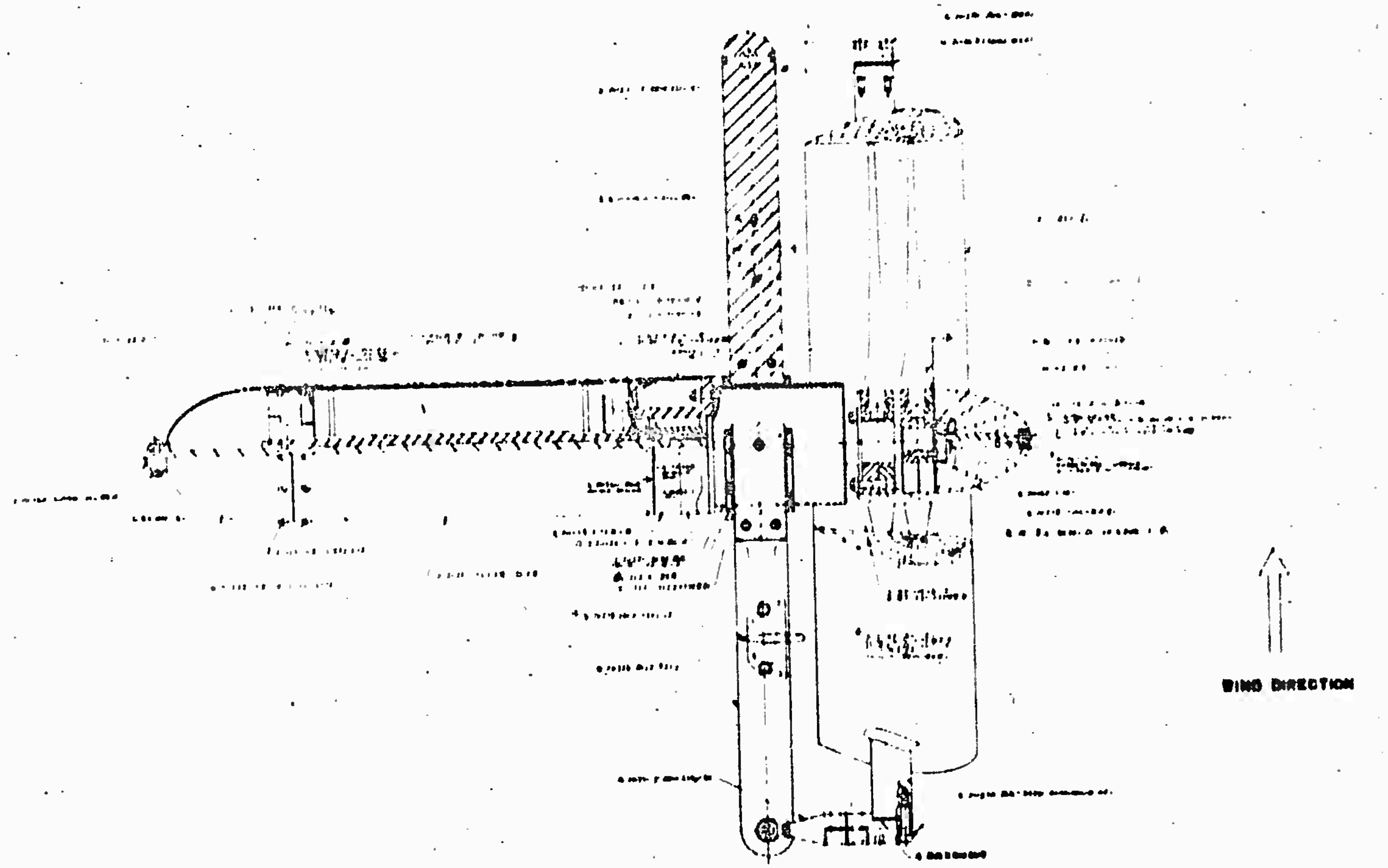


FIGURE 1h: MODEL GENERAL ARRANGEMENT - INLET VIEW

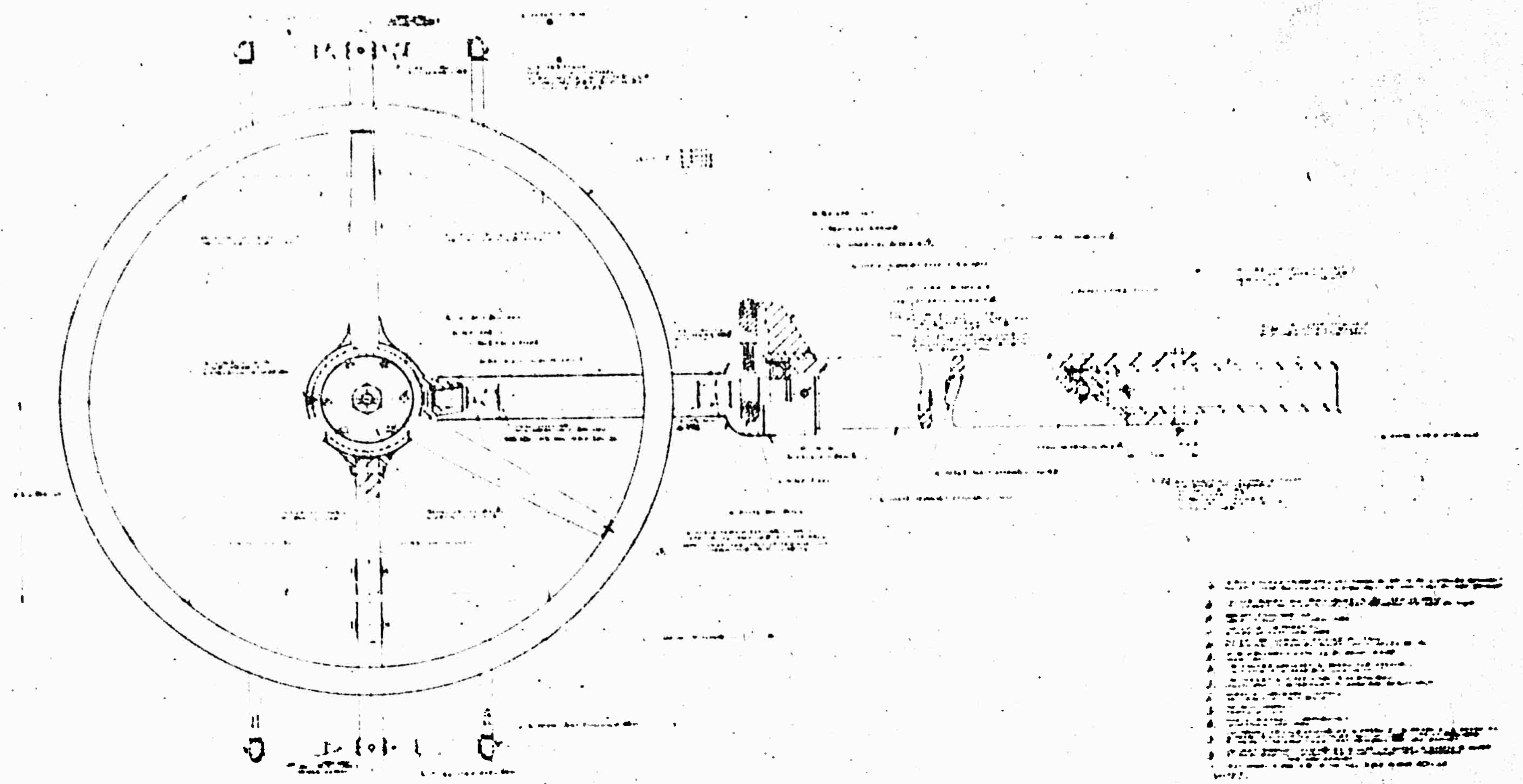


FIGURE 2a: TWO-BLADED PROPELLER HUB ASSEMBLIES

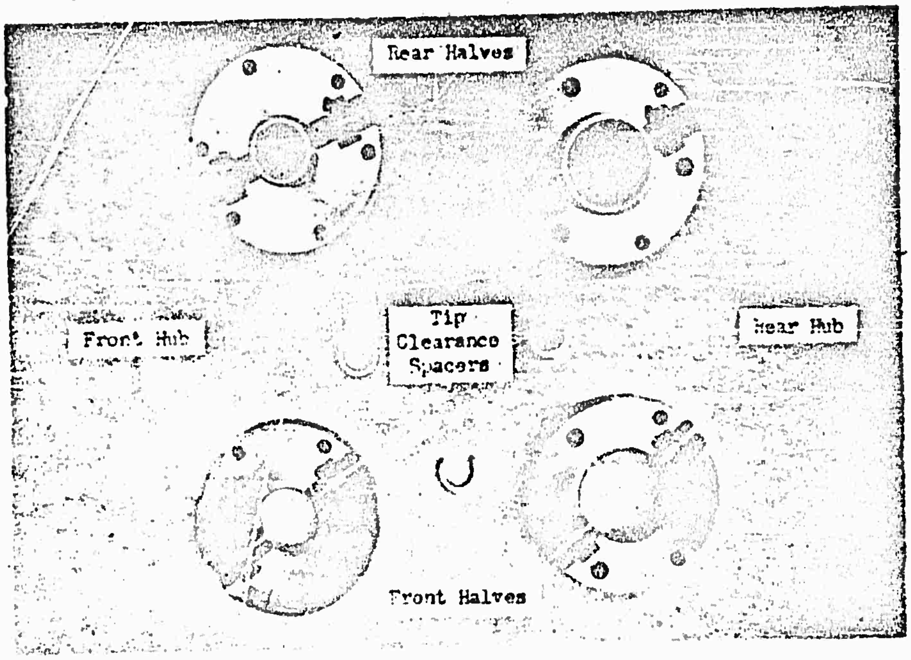


FIGURE 2b: THREE-BLADED PROPELLER HUB ASSEMBLIES

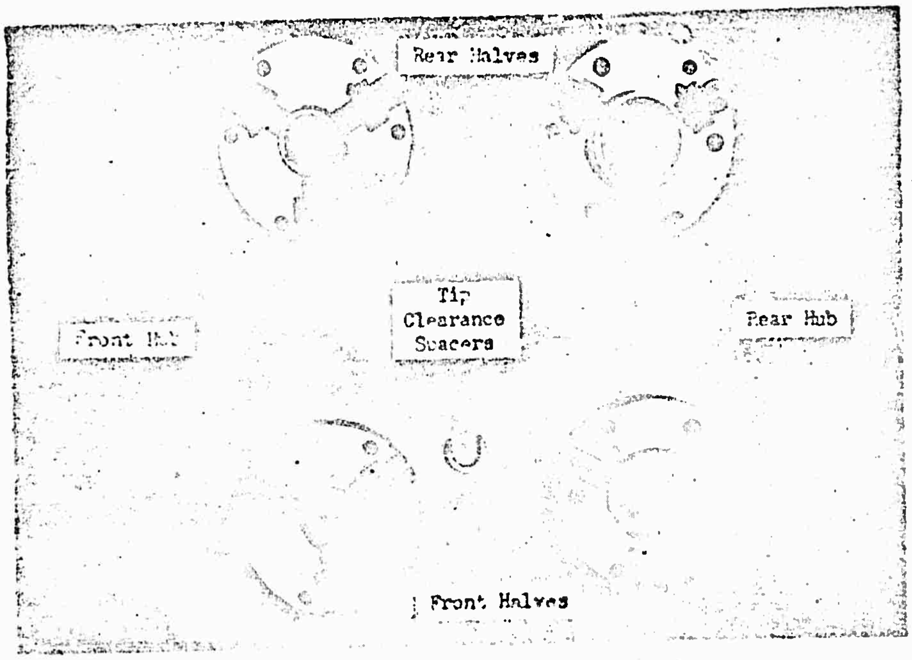


FIGURE 3a: MODEL IN TUNNEL SHOWING DUMMY ELECTRIC MOTOR HOUSING IN DUCT INLET

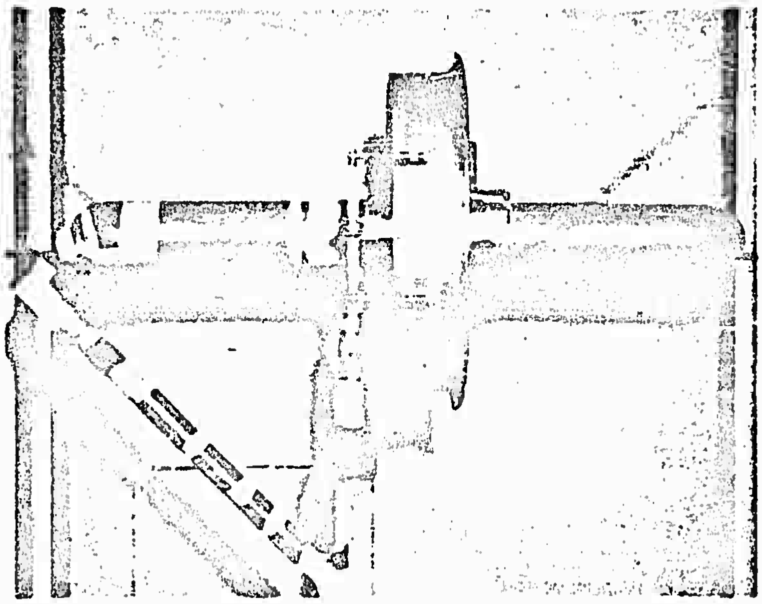


FIGURE 3b: MODEL IN TUNNEL SHOWING SIMULATED PLATFORM ENGINES

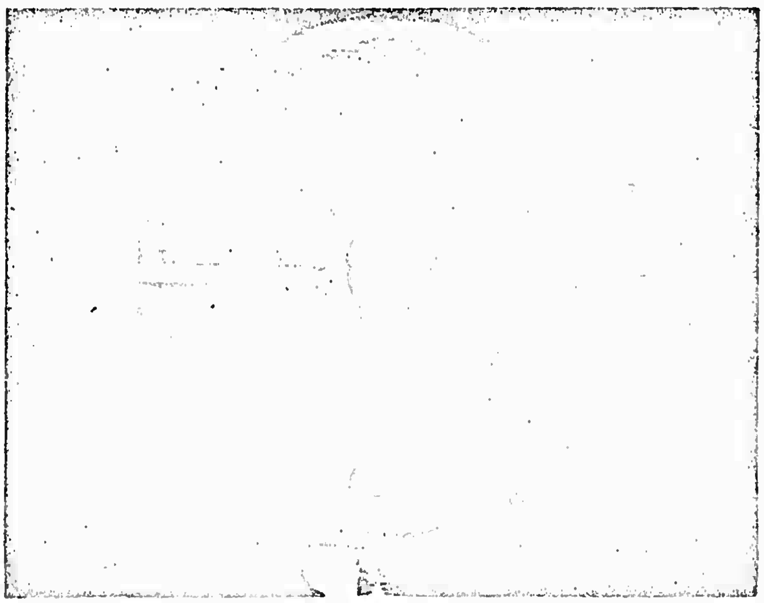


FIGURE 3c: DETAILS OF SIMULATED PLATFORM TYPE ENGINES FOR MODEL

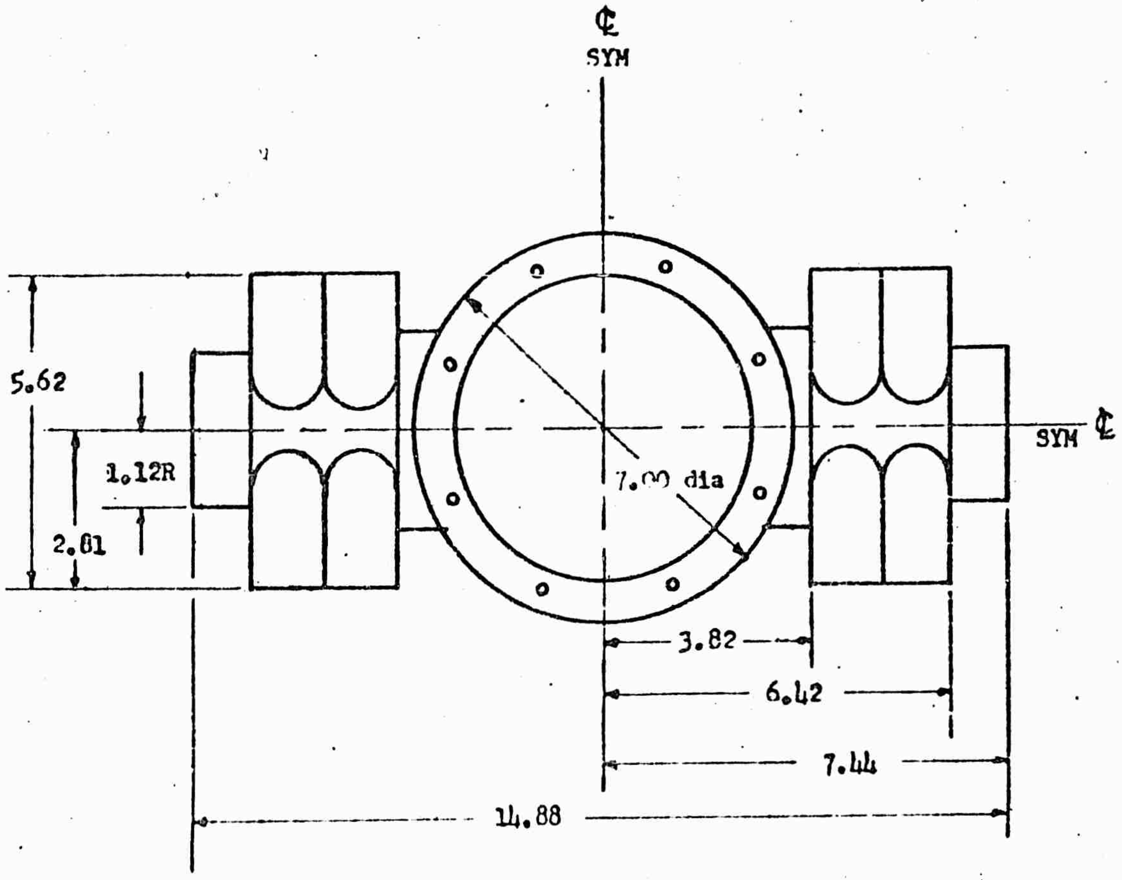


FIGURE 4: MODEL WITHOUT PROPELLERS AND HUBS, SHOWING DUCT POSITIONING THREADS ON TRANSMISSION

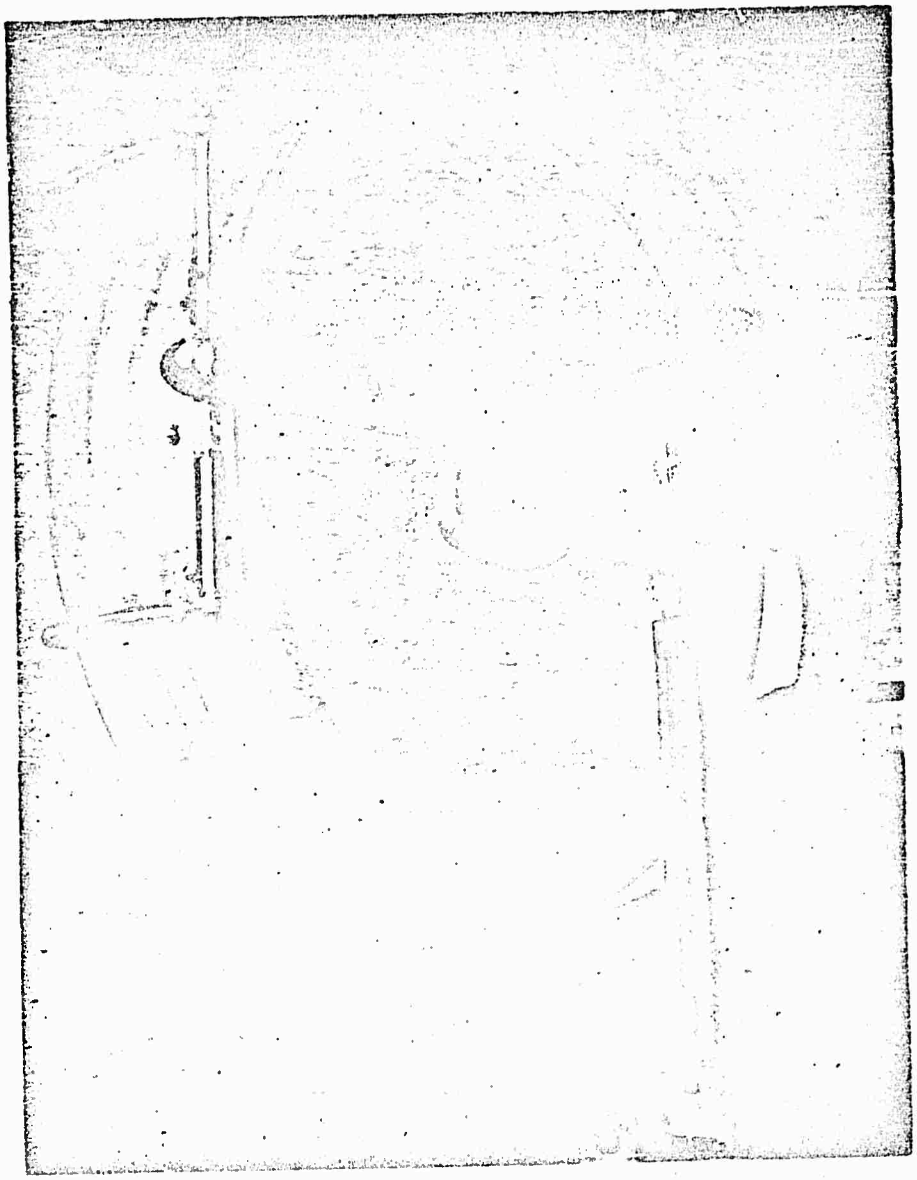


FIGURE 5: MODEL ORIENTATION IN WIND TUNNEL TEST SECTION

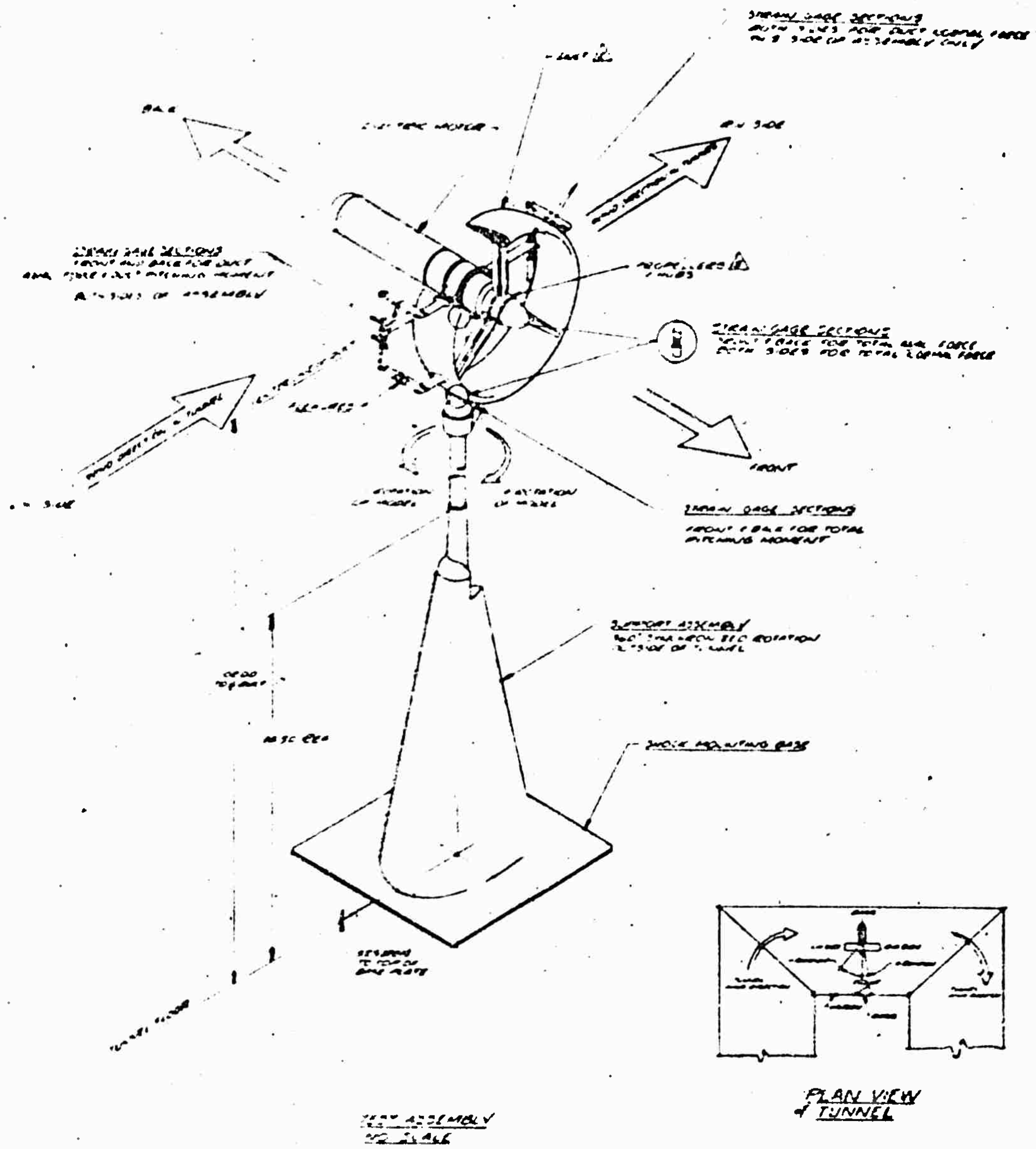


FIGURE 4: MODEL MOUNTED ON STATIC TEST STAND (Viewed from rear)

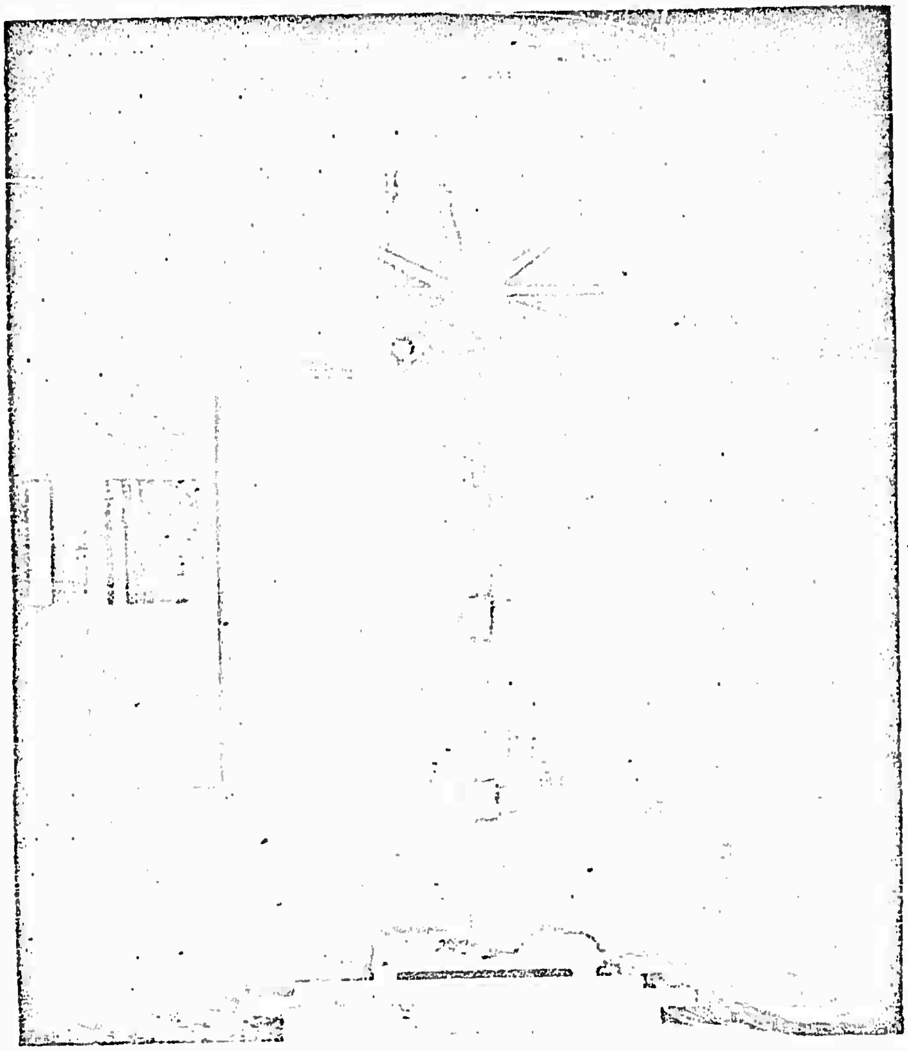


FIGURE 7: TUFT STUDY OF MODEL D_2P_3S OPERATING ON STATIC STAND

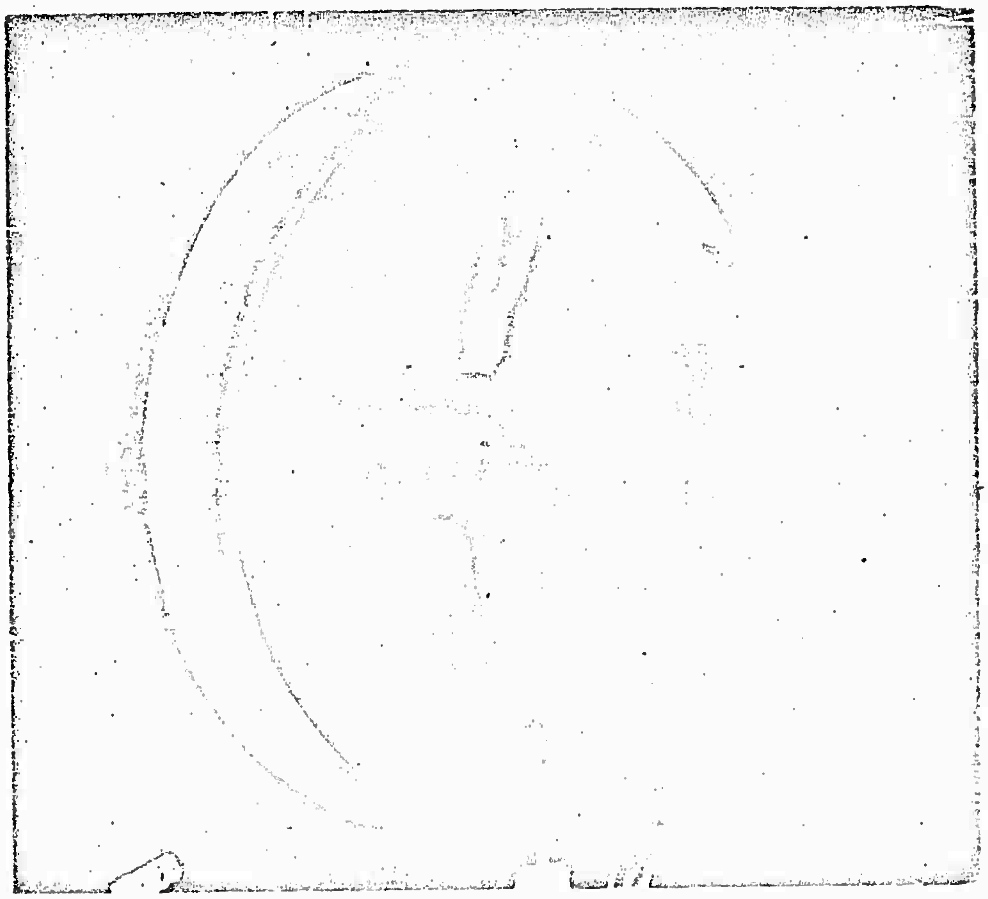


FIGURE 8: OIL PATTERN ON DUCT 2 AFTER STATIC OPERATION OF MODEL D_2P_3S

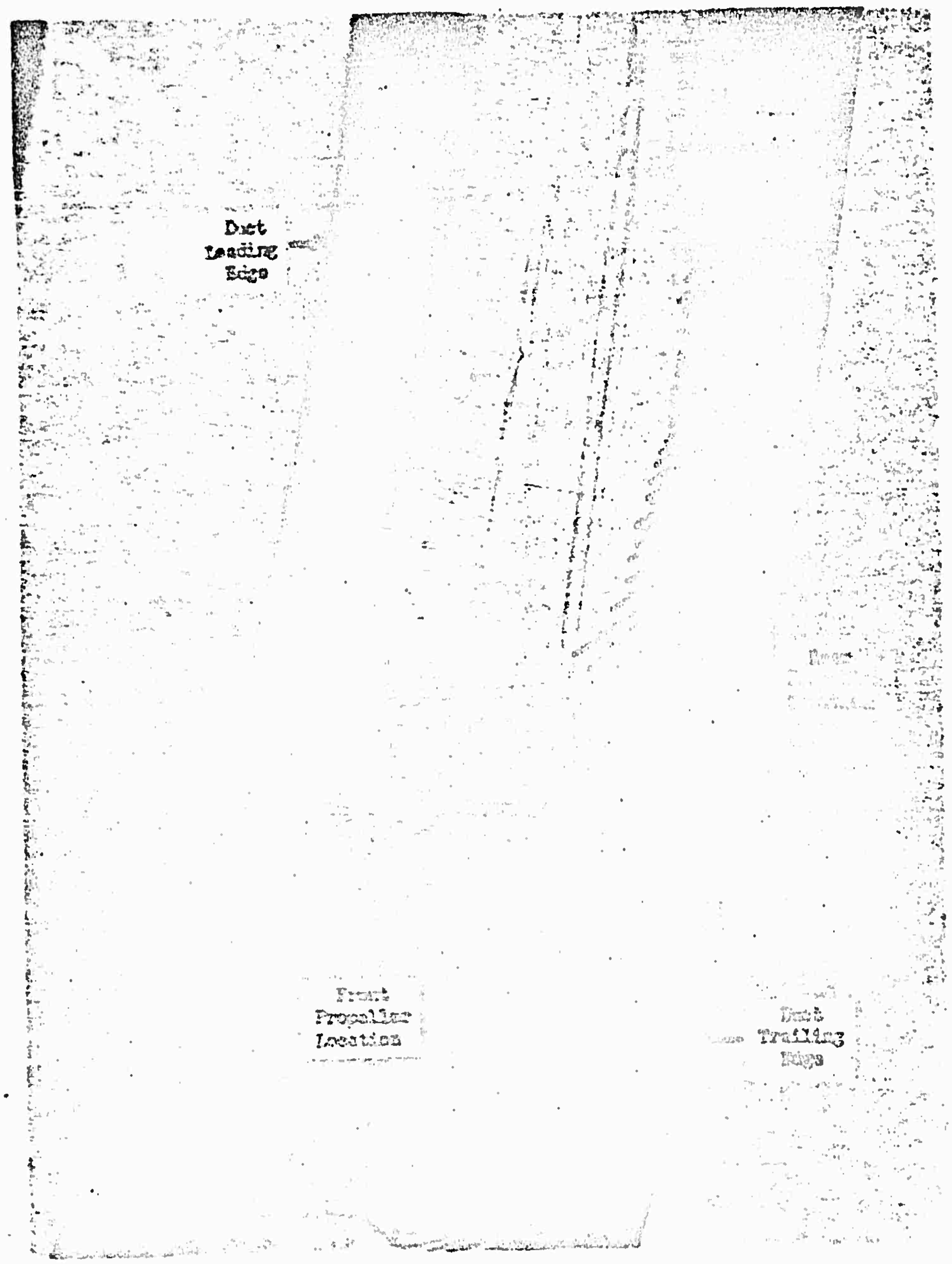


FIGURE 9: TWO VIEWS OF DAMAGED TWO-BLADED CONTRA-ROTATING PROPELLERS

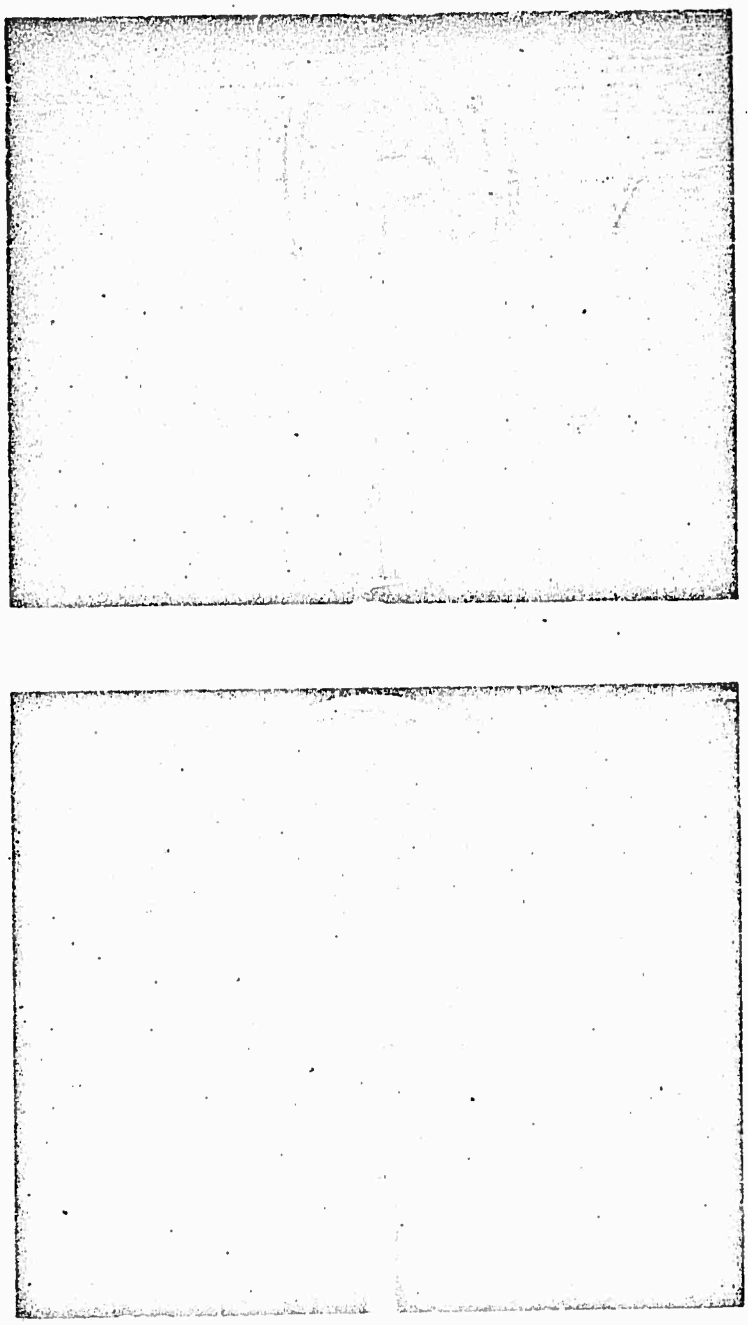


FIGURE 10a: TUFT STUDY OF MODEL D_1P_3S OPERATING IN TUNNEL
(λ=0.05 α=0° Wind from left to right)

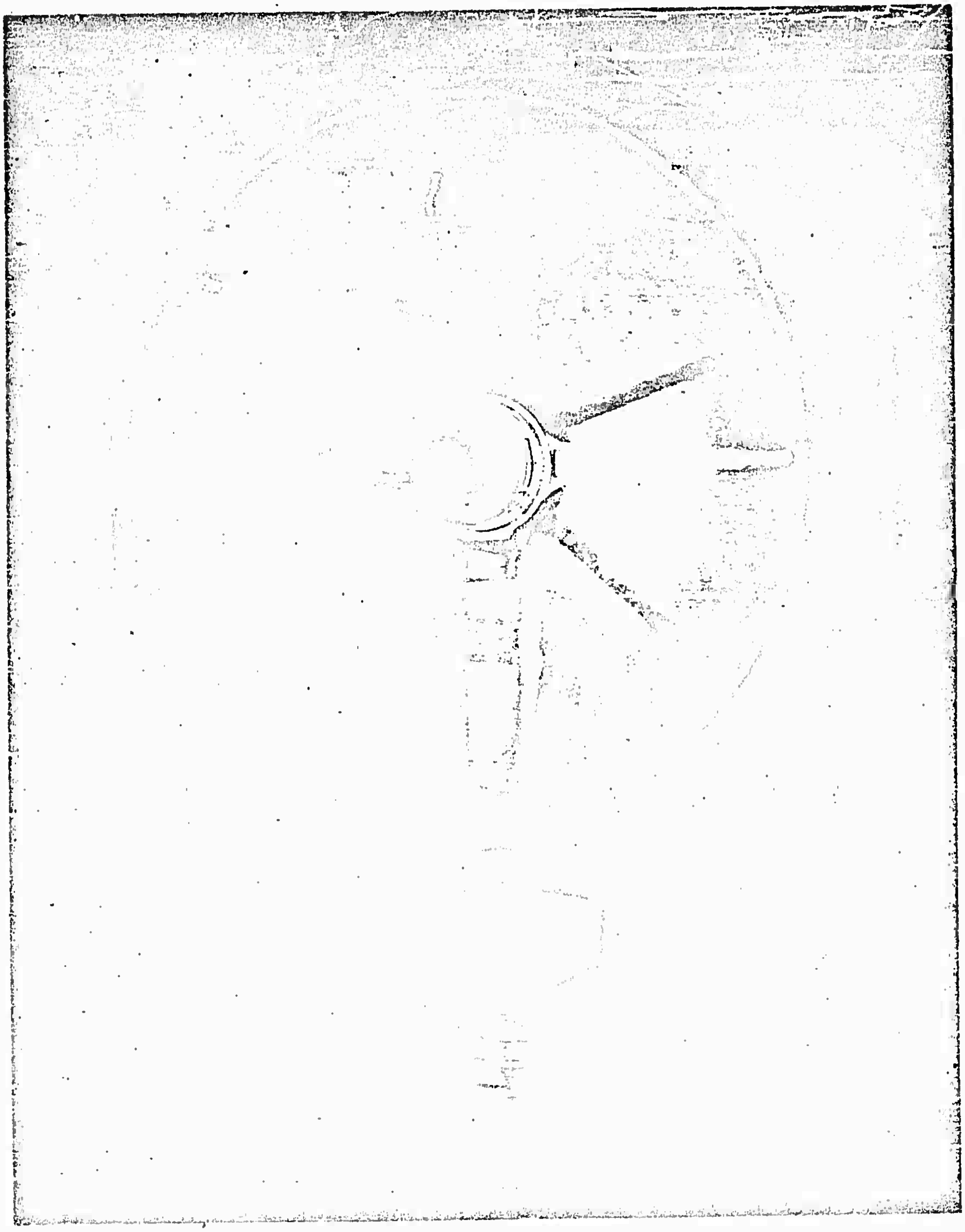


FIGURE 10b: TUFT STUDY OF MODEL D_1P_3S OPERATING IN TUNNEL
(λ=0.05 α=22° k_F=0 Wind from left to right)

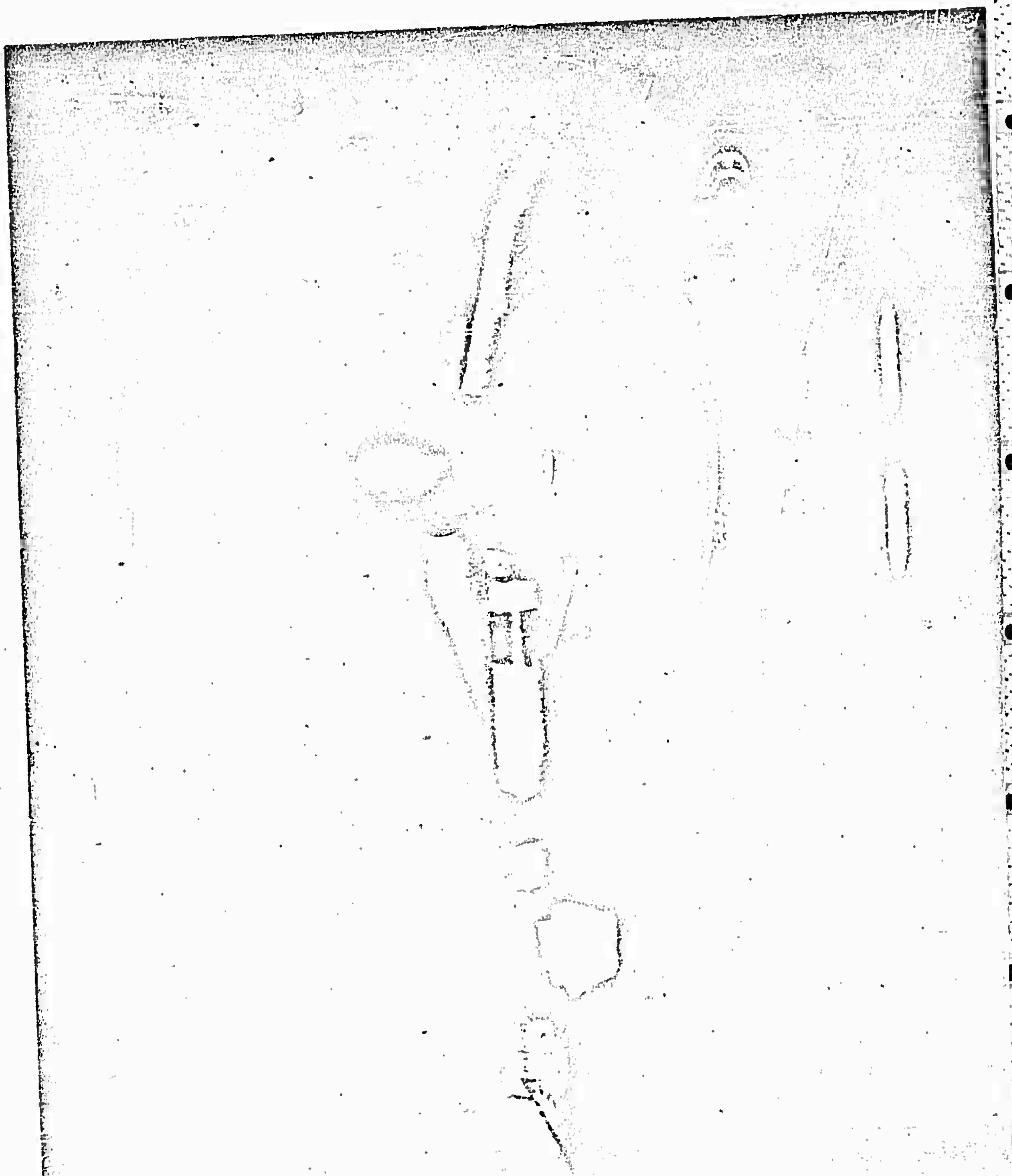


FIGURE 10d: TUFT STUDY OF MODEL D_1P_3S OPERATING IN TUNNEL
(λ=.15 α=55° k_F=0 Wind from left to right)

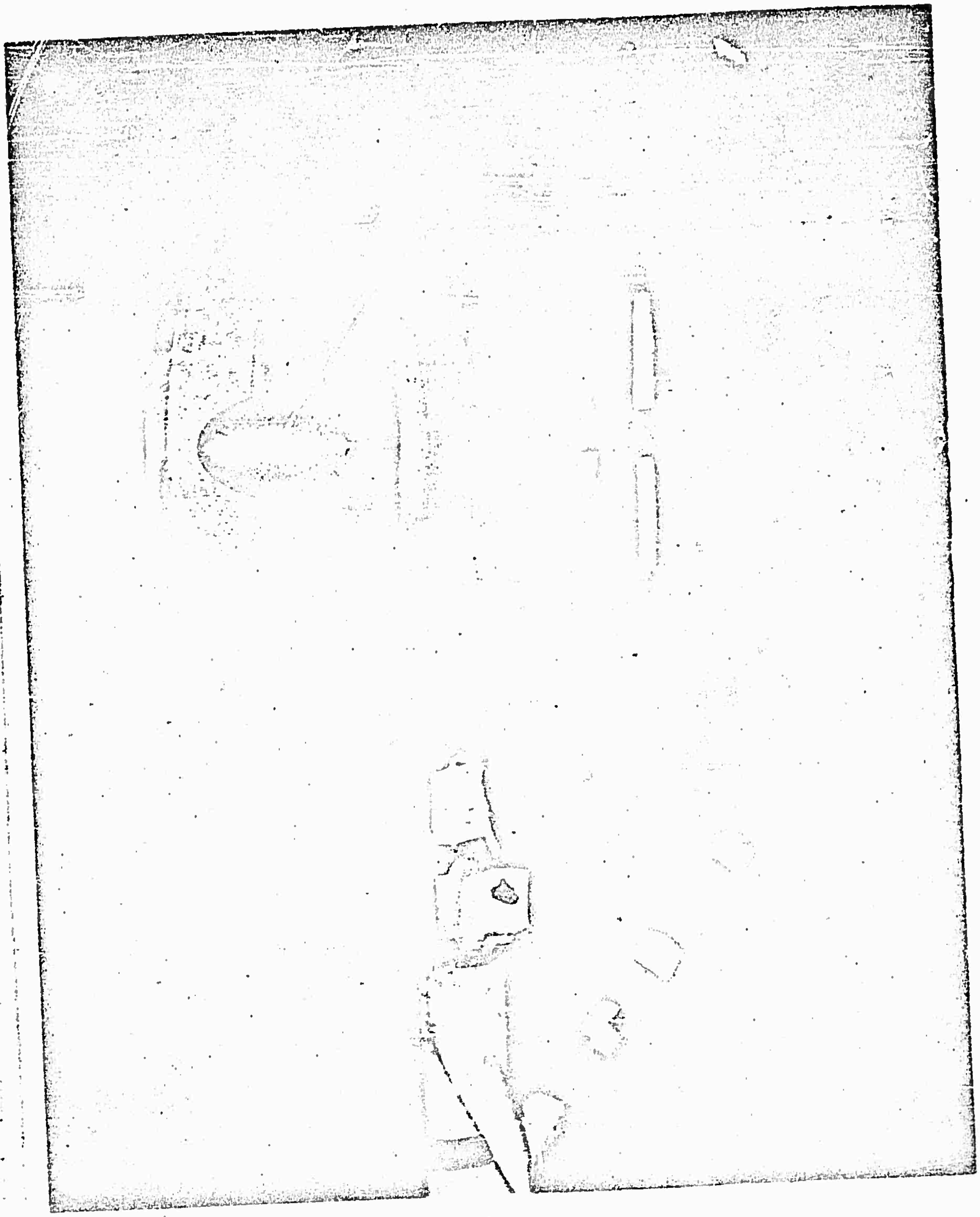


FIGURE 10c: TUFT STUDY OF MODEL D_1P_3S OPERATING IN TUNNEL
(λ=0.10 α=37° k_p=0 Wind from left to right)

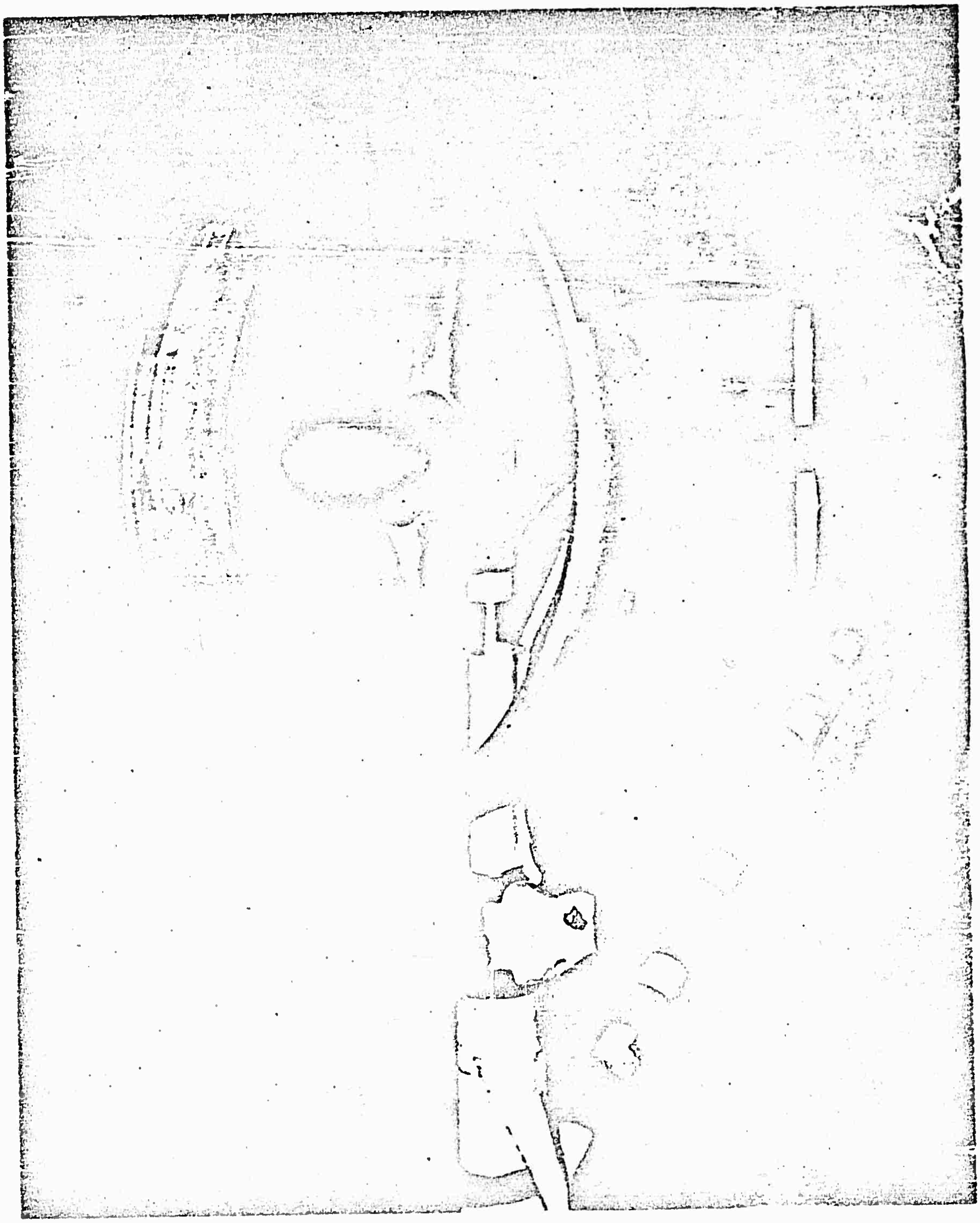


FIGURE 11 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

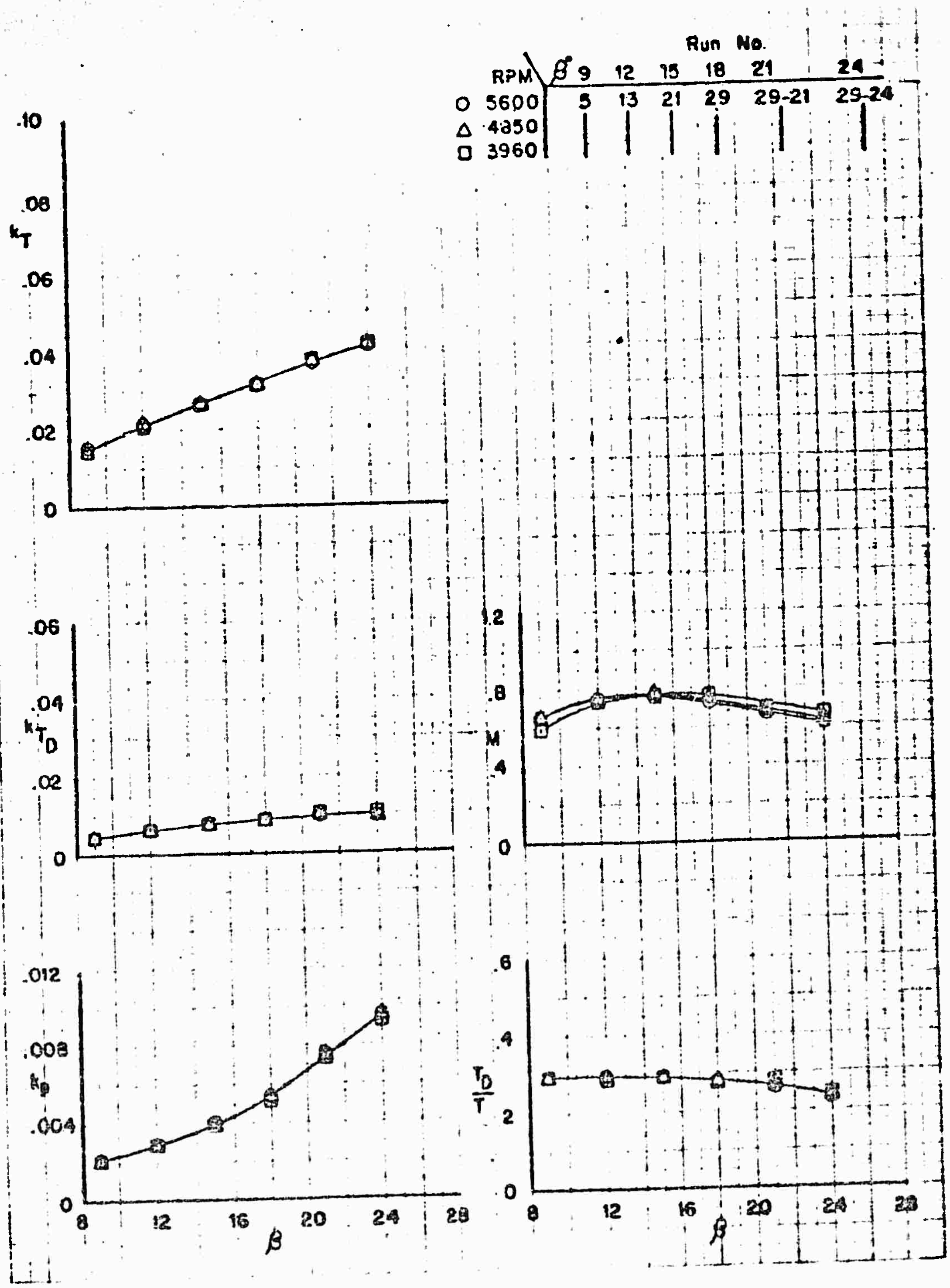


FIGURE 12 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2R_3S

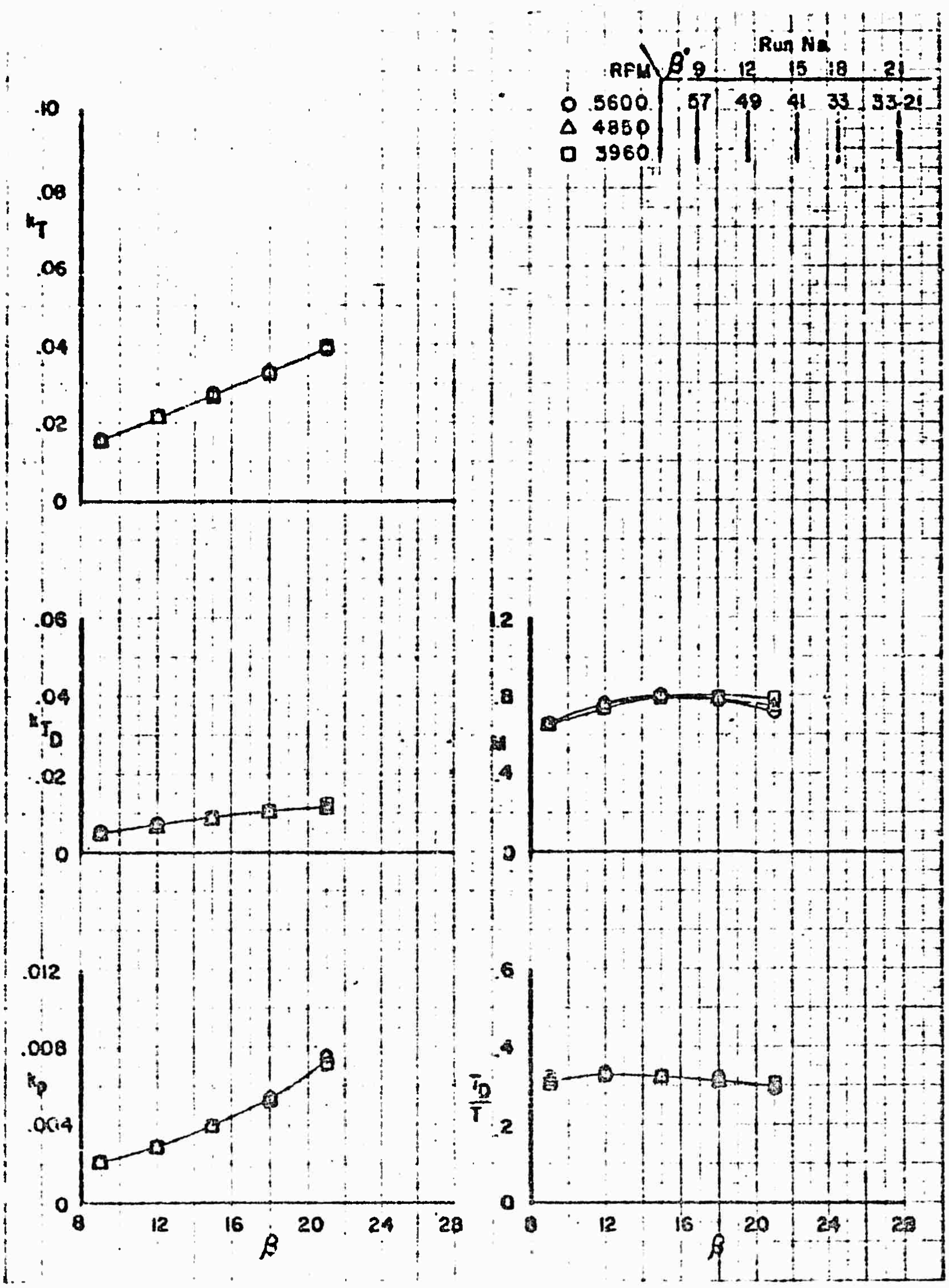


FIGURE 13 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

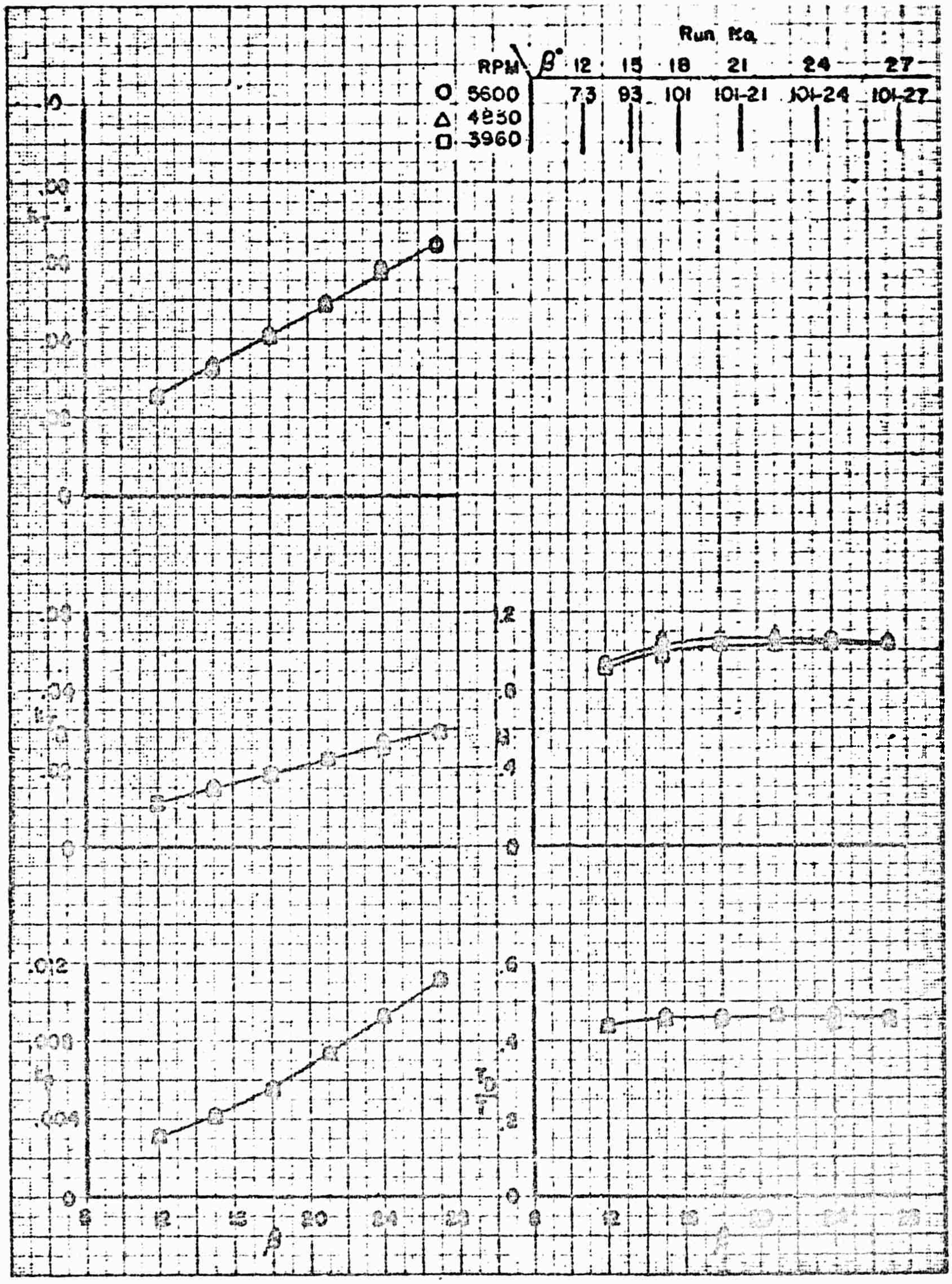


FIGURE 14 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

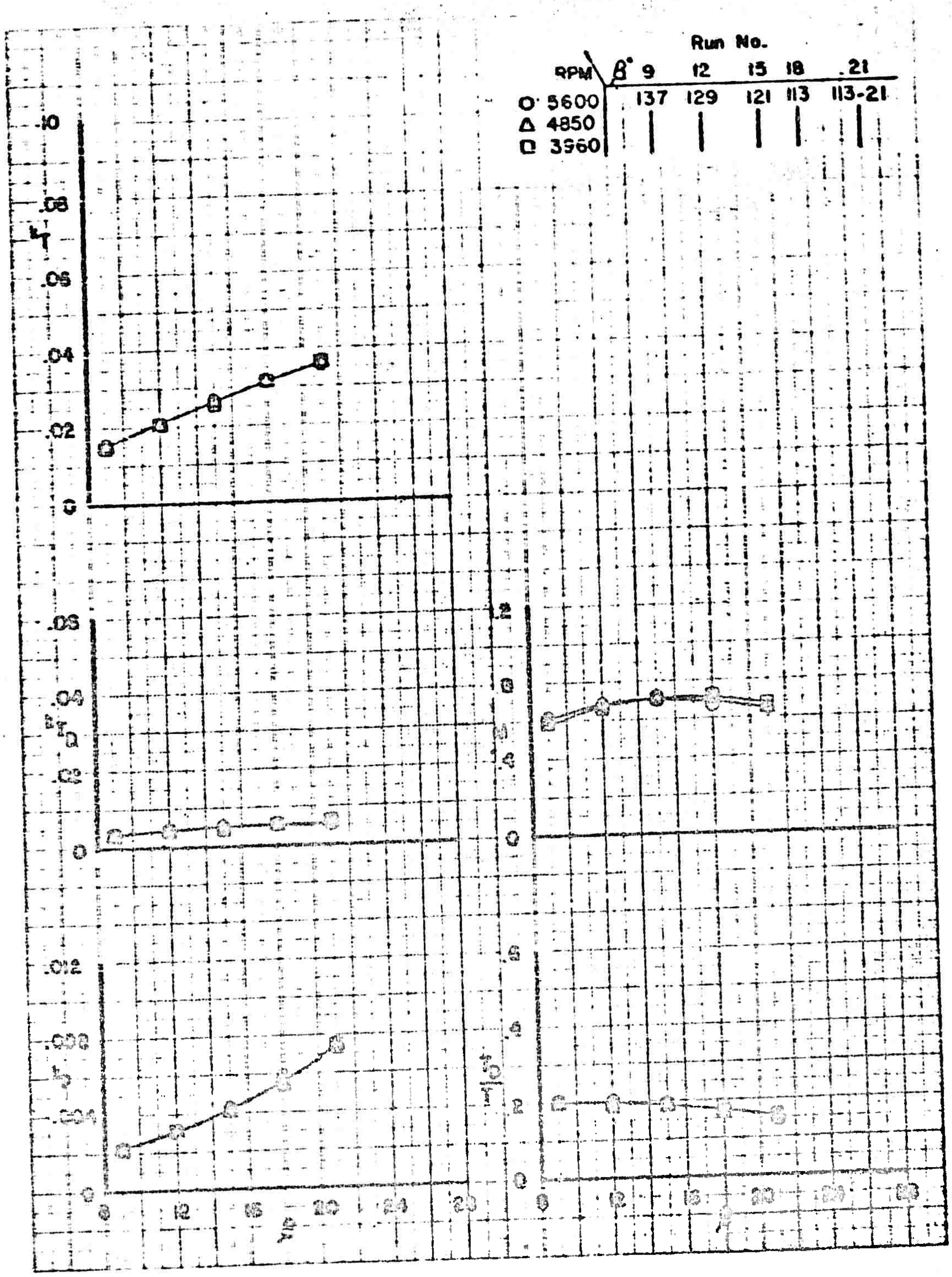


FIGURE 15 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_2S

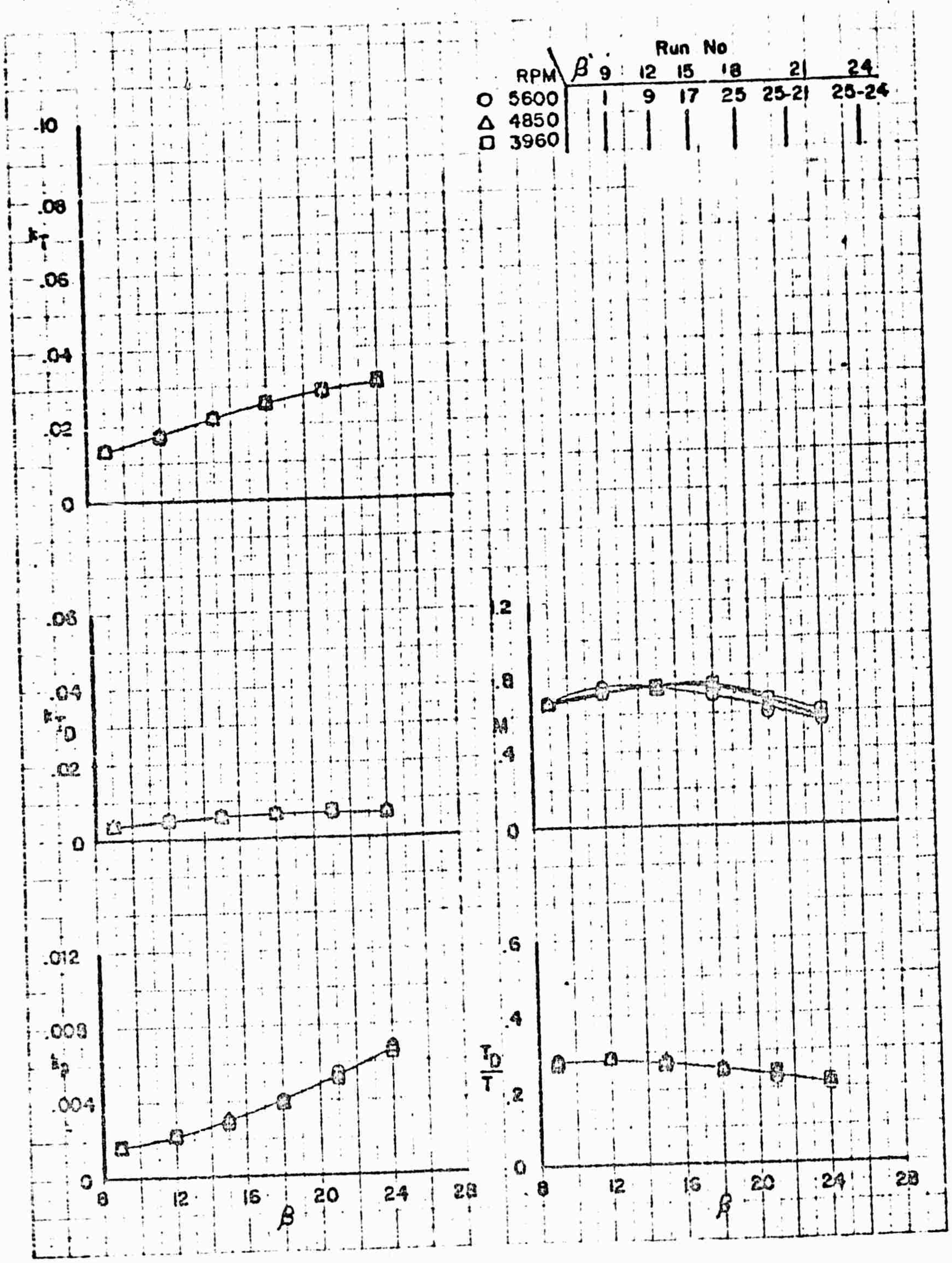


FIGURE 16 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_2S

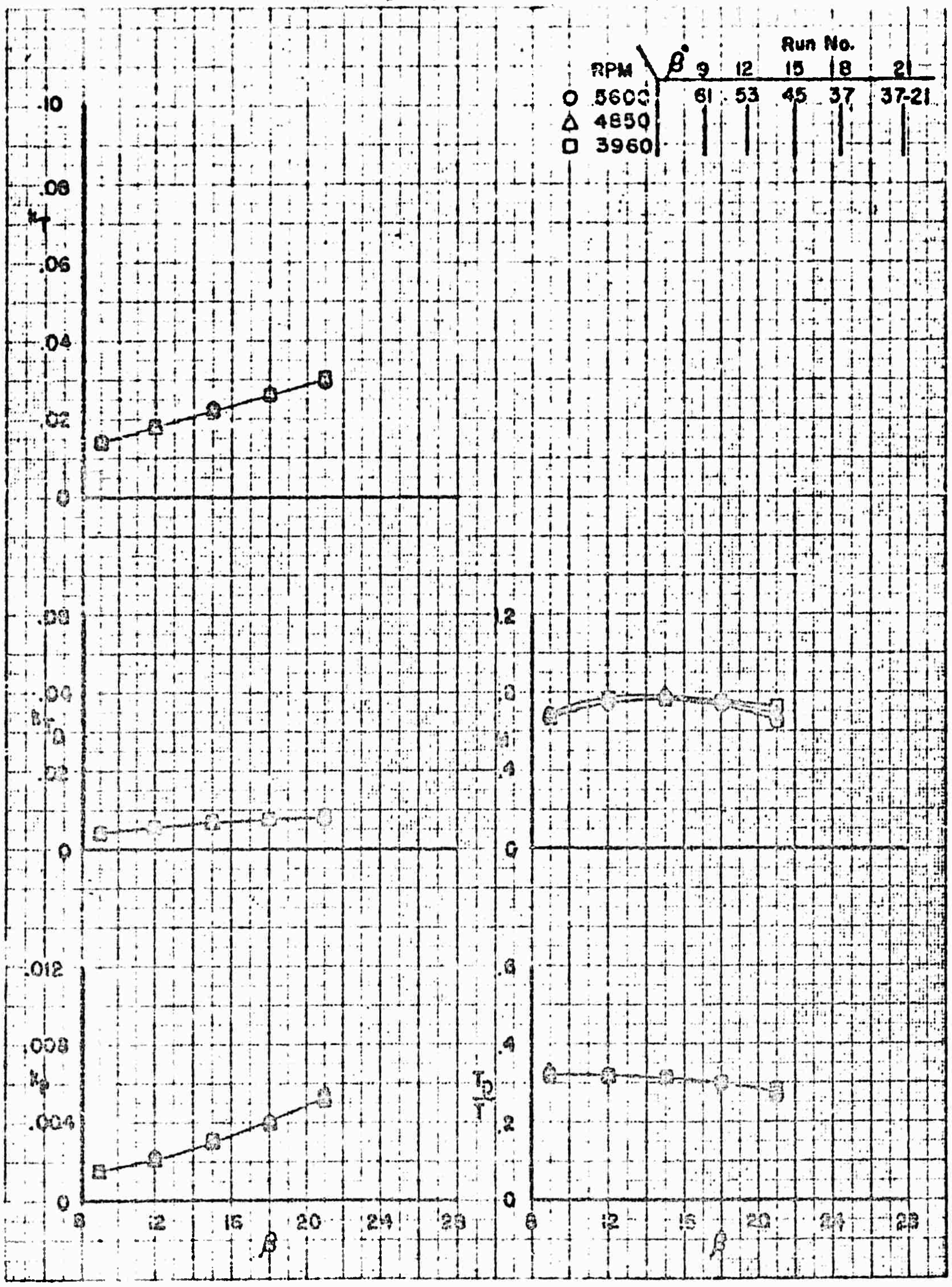


FIGURE 17 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S

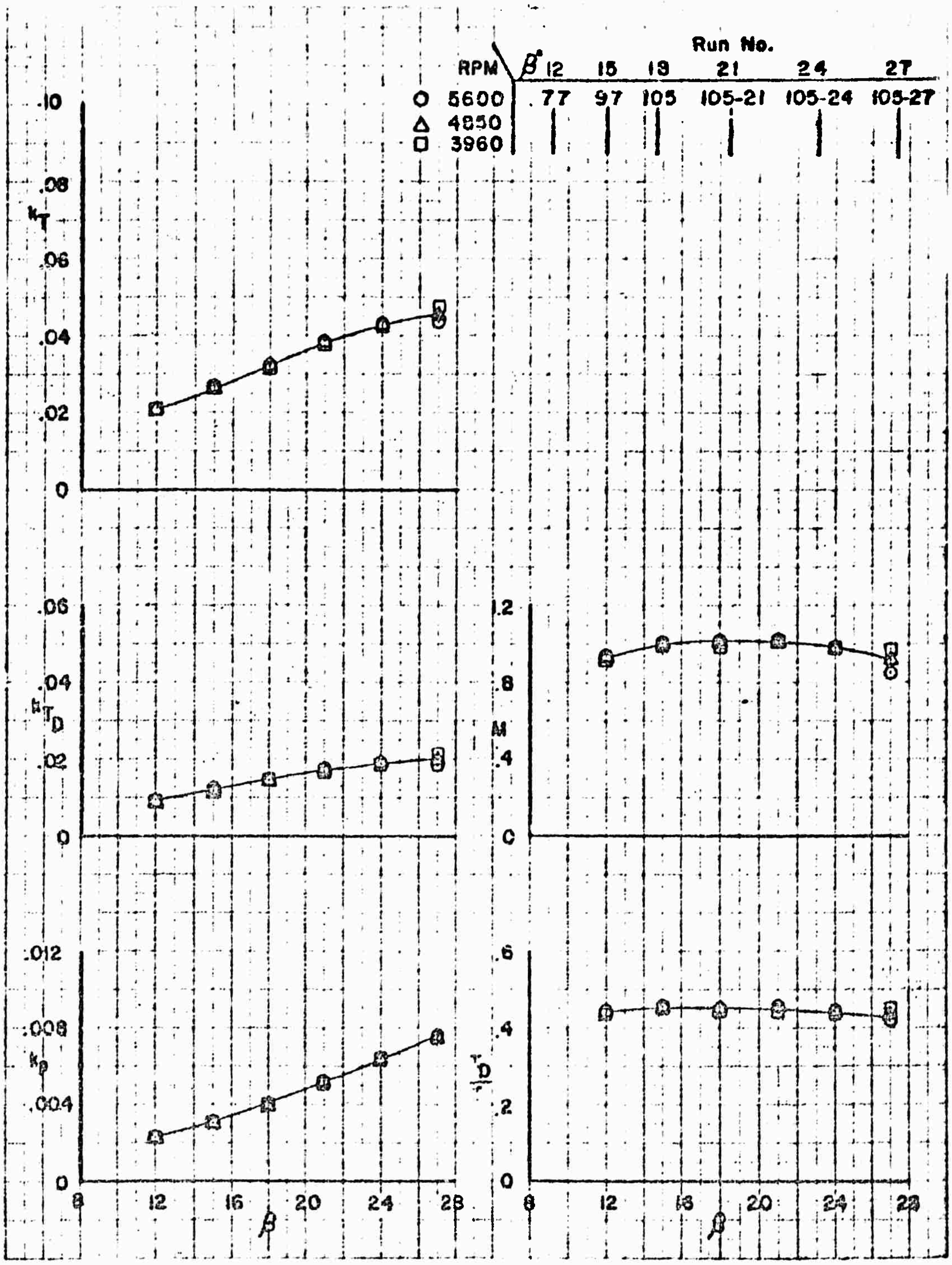


FIGURE 18 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_2S

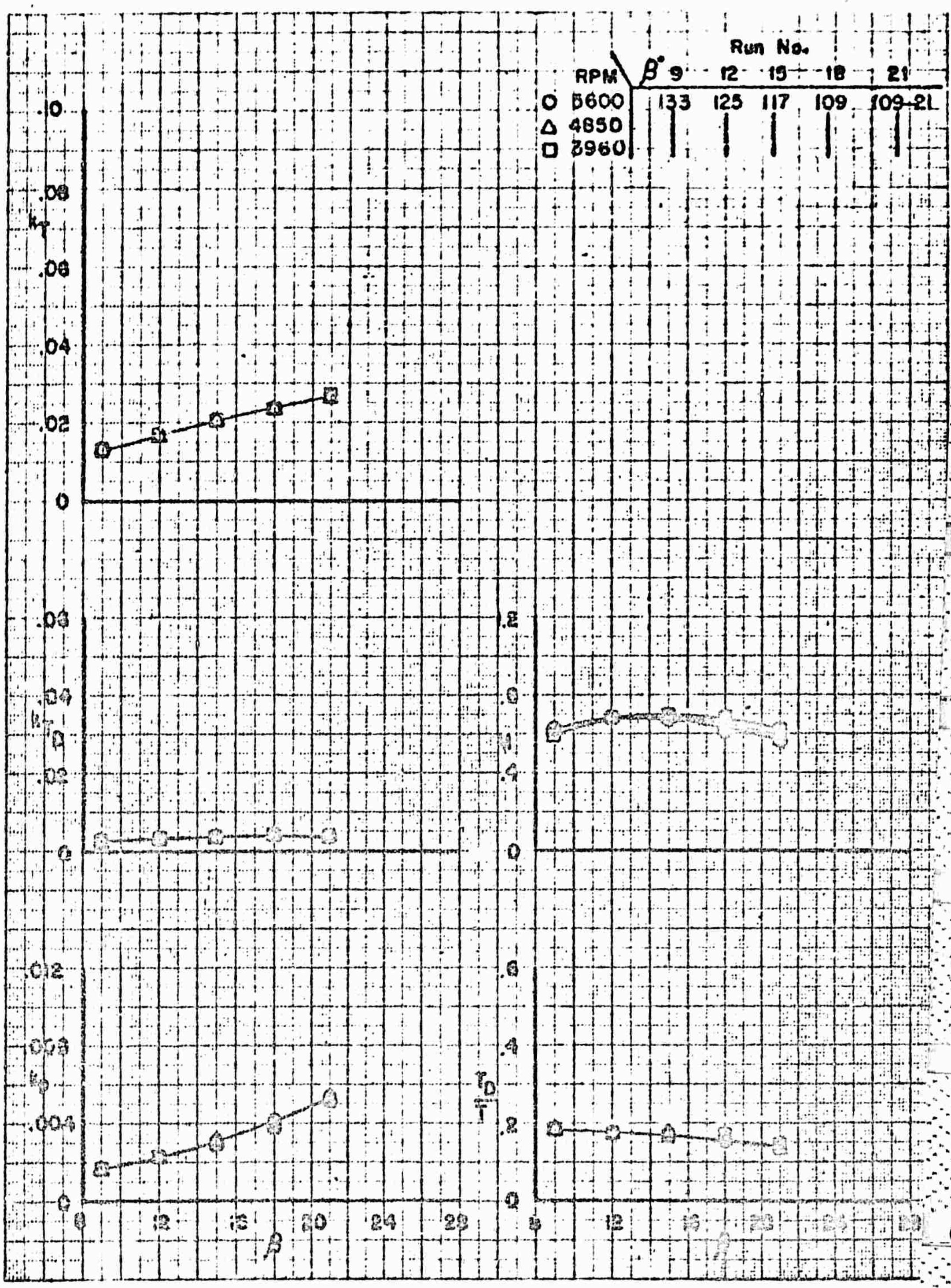


FIGURE 19 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_pS

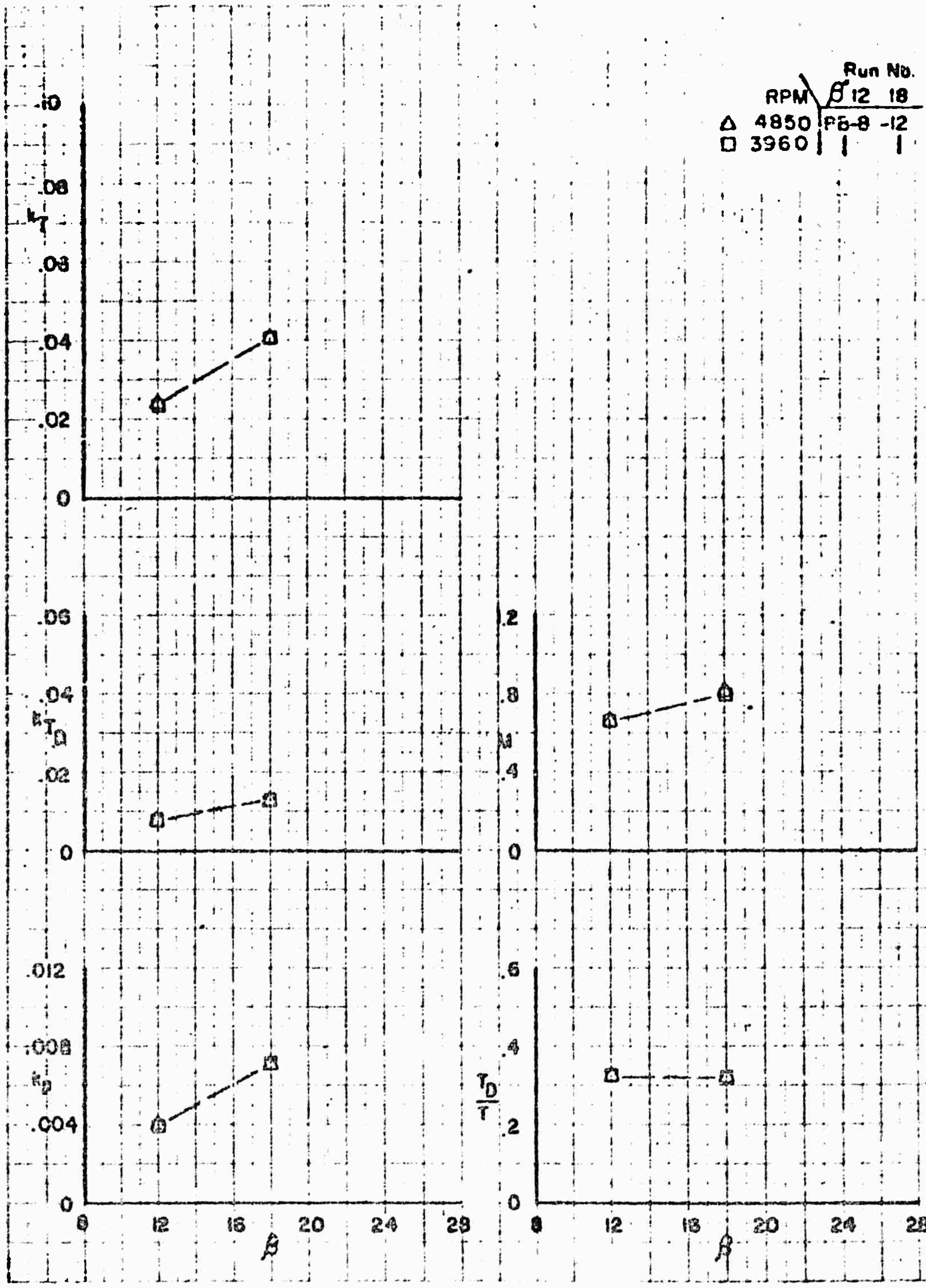


FIGURE 20 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_pS

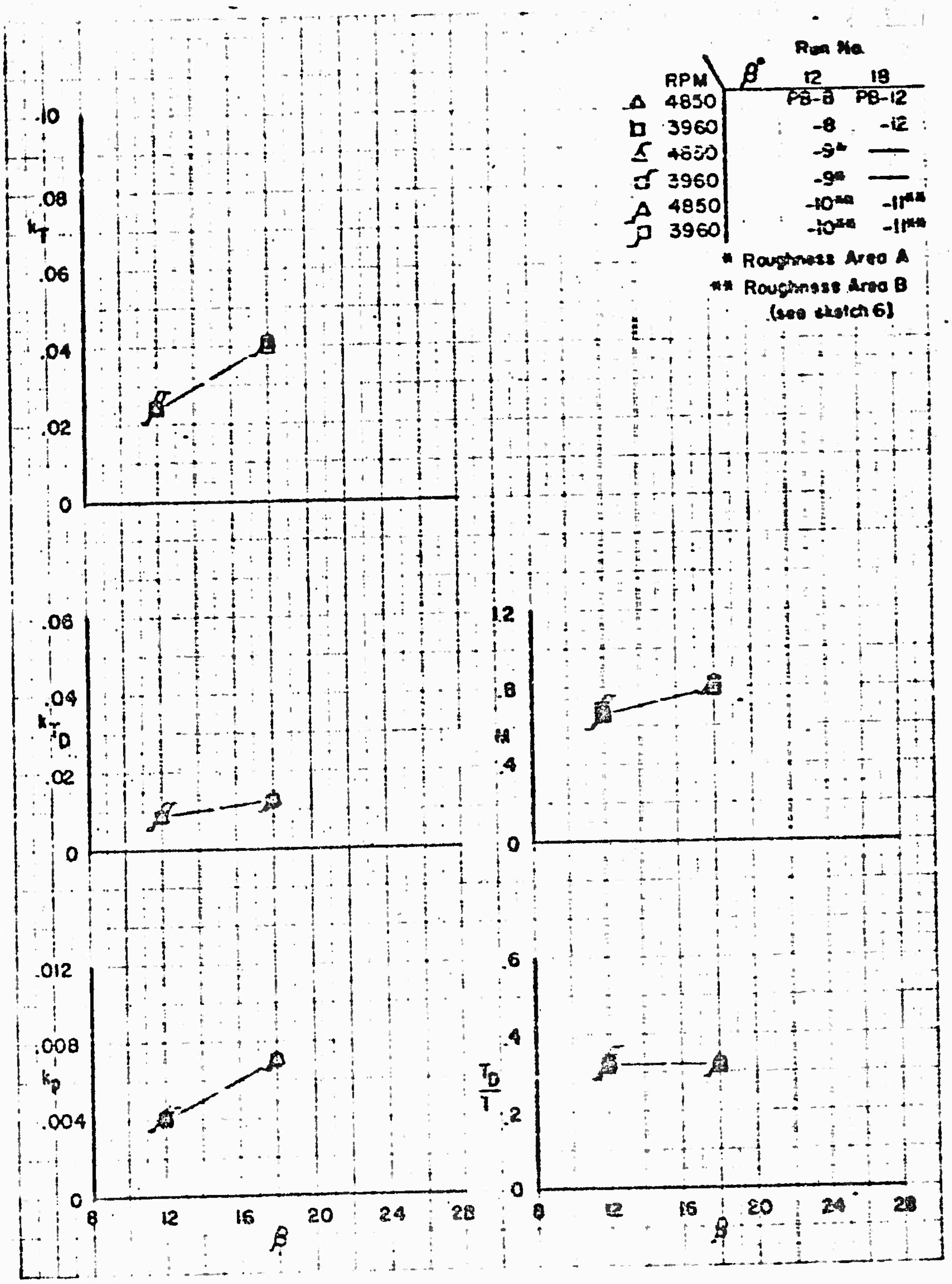


FIGURE 21 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_pS

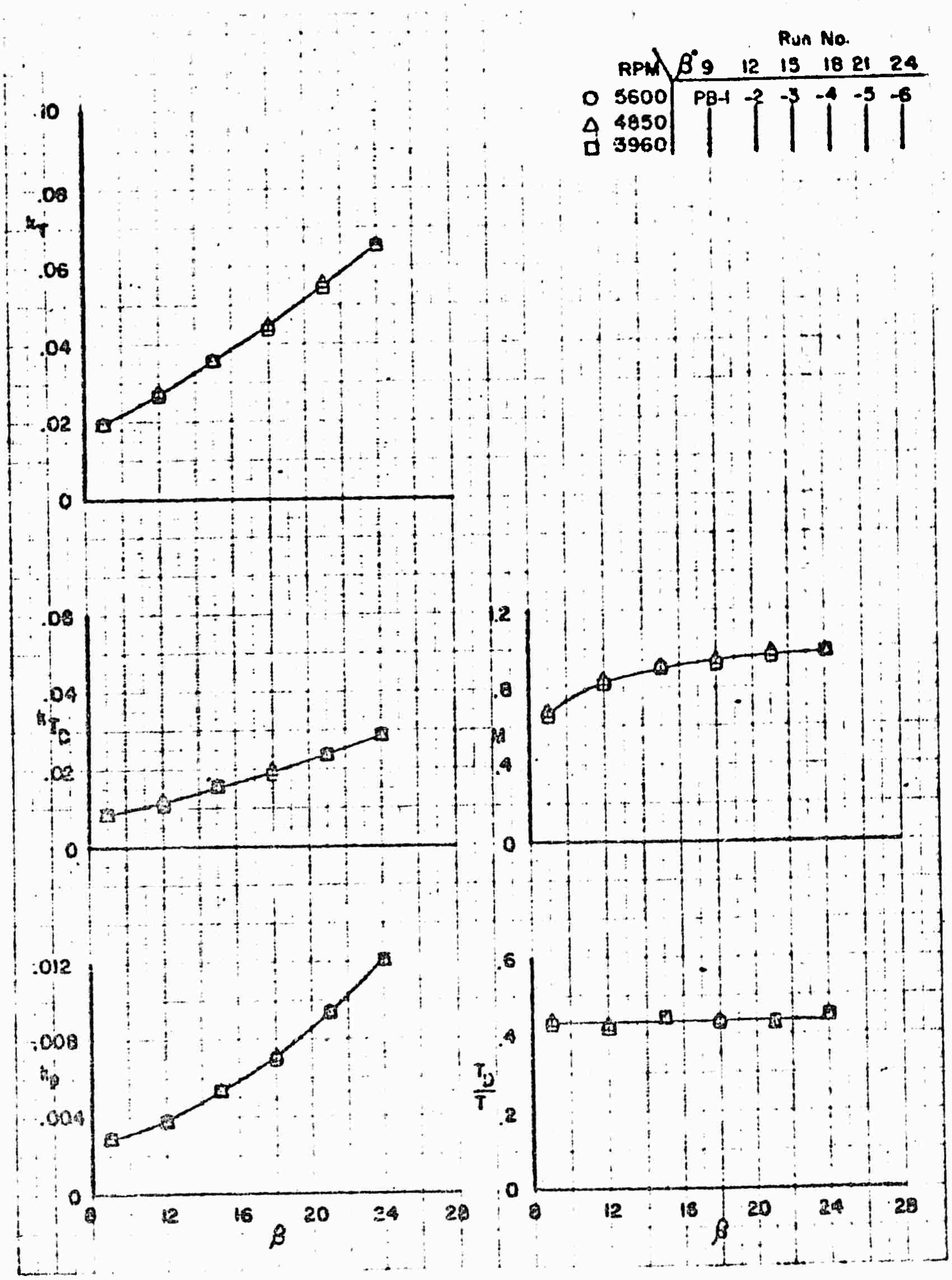


FIGURE 22 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_2S

D_4P_2E (Flagged Symbols)

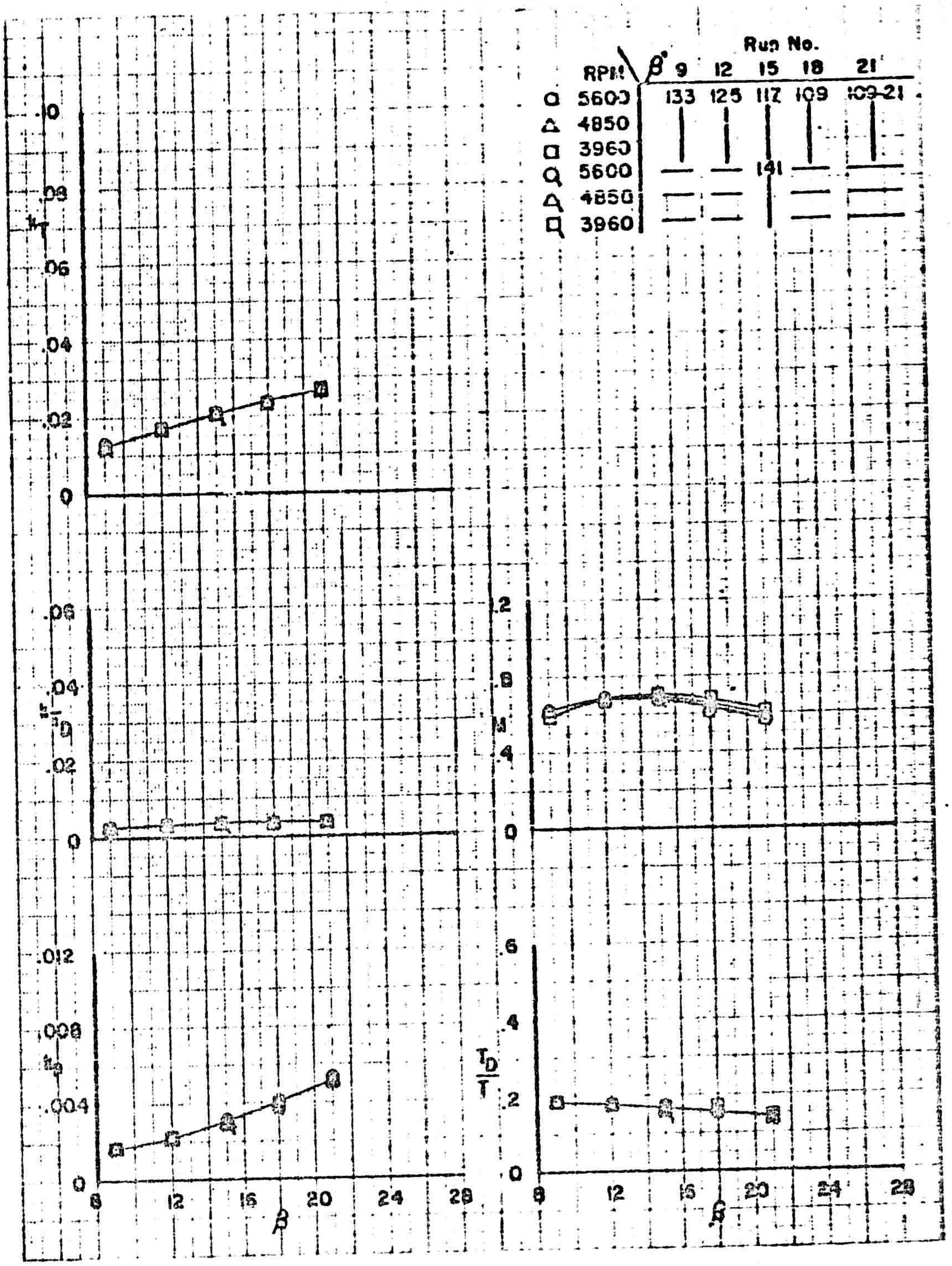


FIGURE 23 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_2S
D_4P_2HE (Flagged Symbols)

RPM \ β°	9	12	15	18	21
	Run No.				
○ 5600	133	125	117	109	109-21
△ 4850					
□ 3960					
Q 5600	—	—	145	—	—
△ 4850	—	—		—	—
Q 3960	—	—		—	—

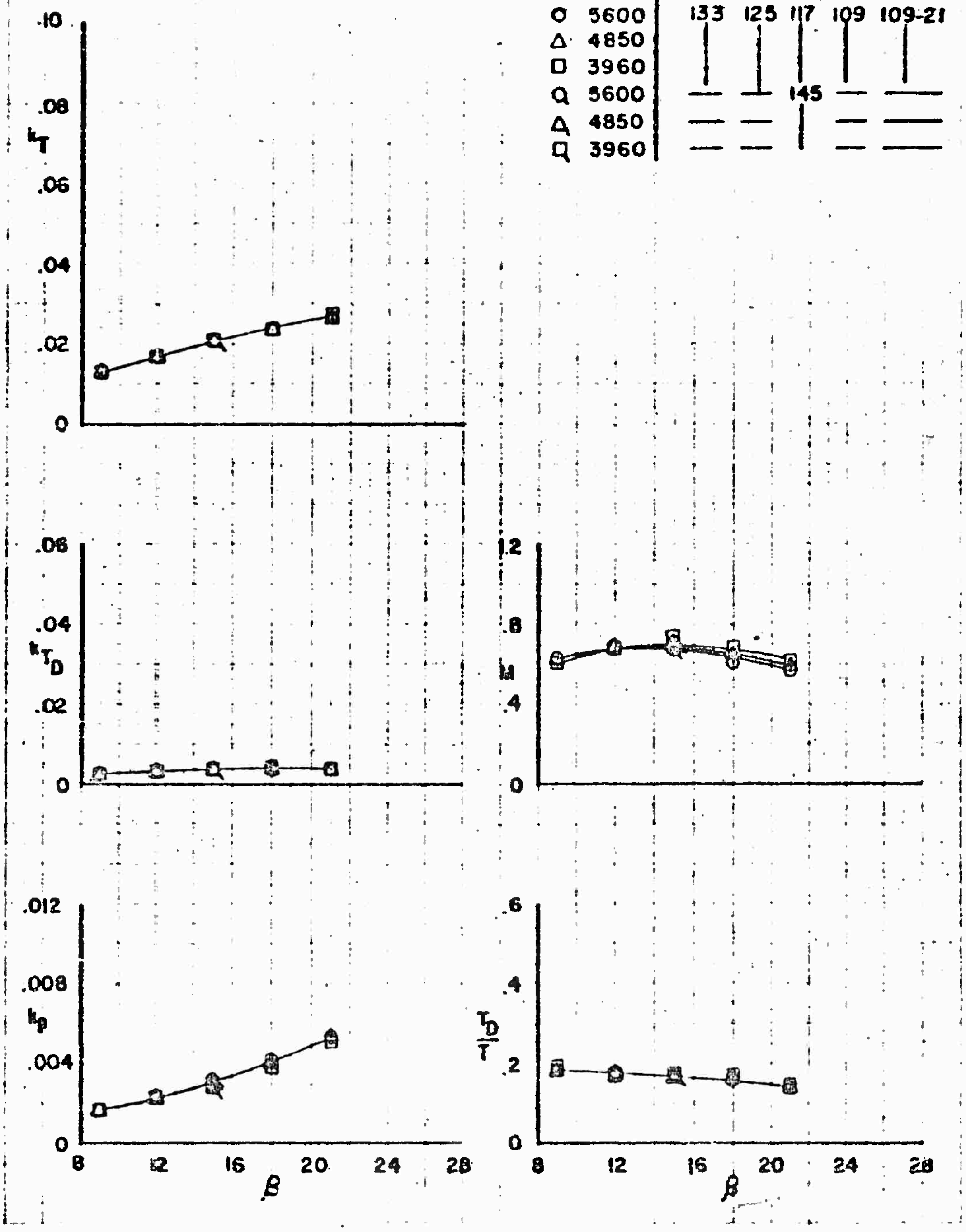


FIGURE 24 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_2S

D_4P_2BE (Flagged Symbols)

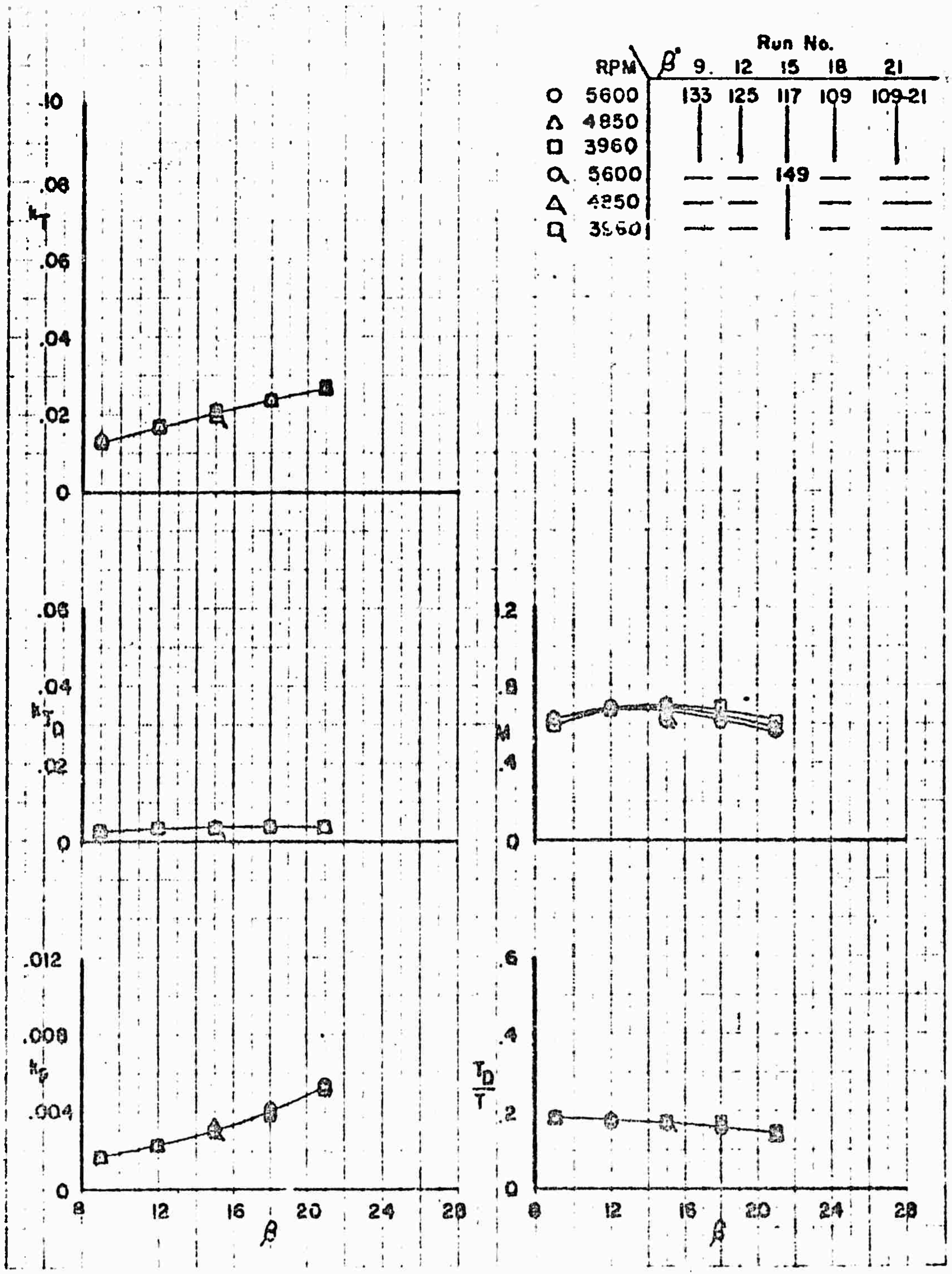


FIGURE 25 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

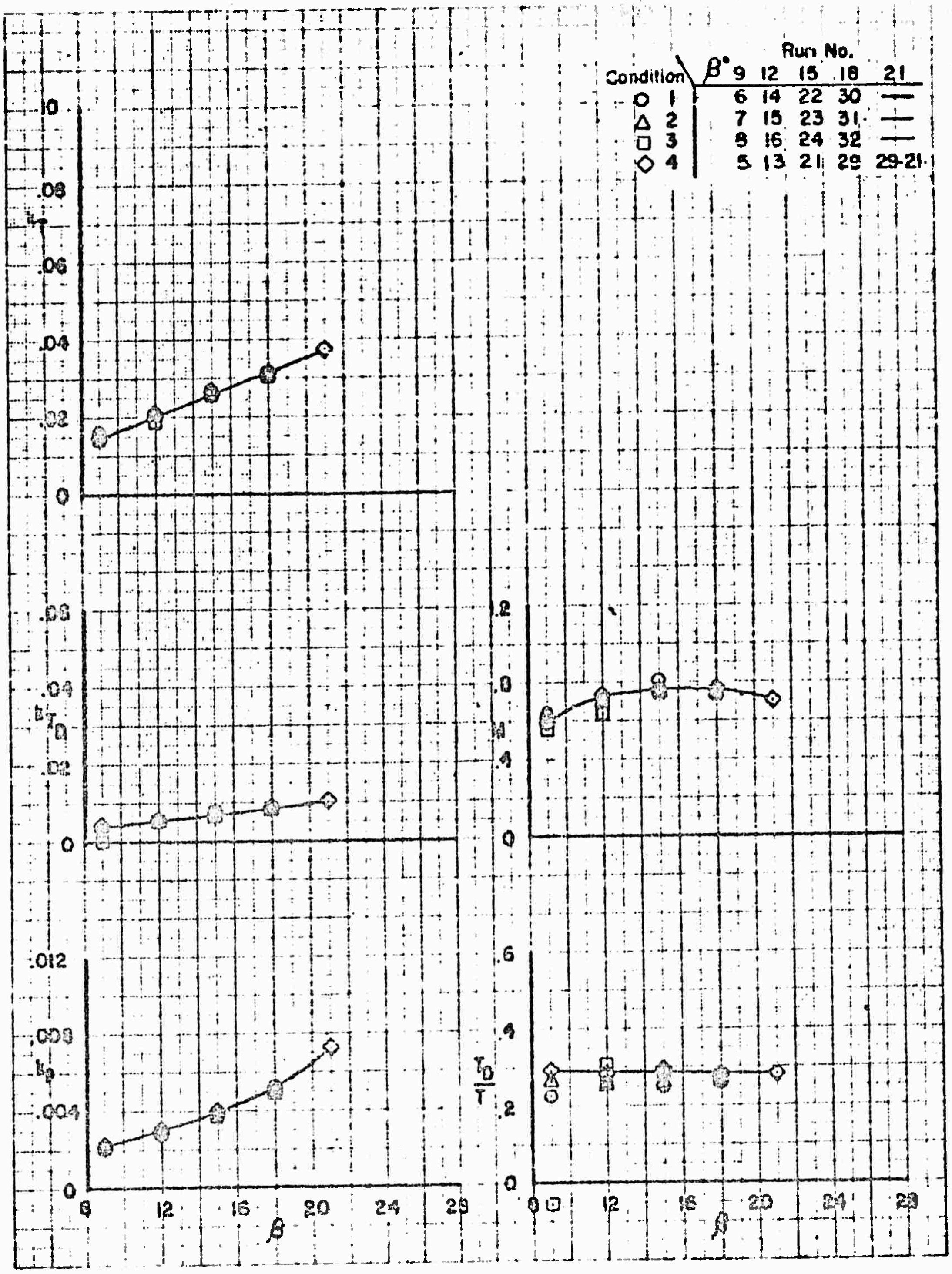


FIGURE 26 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_3S

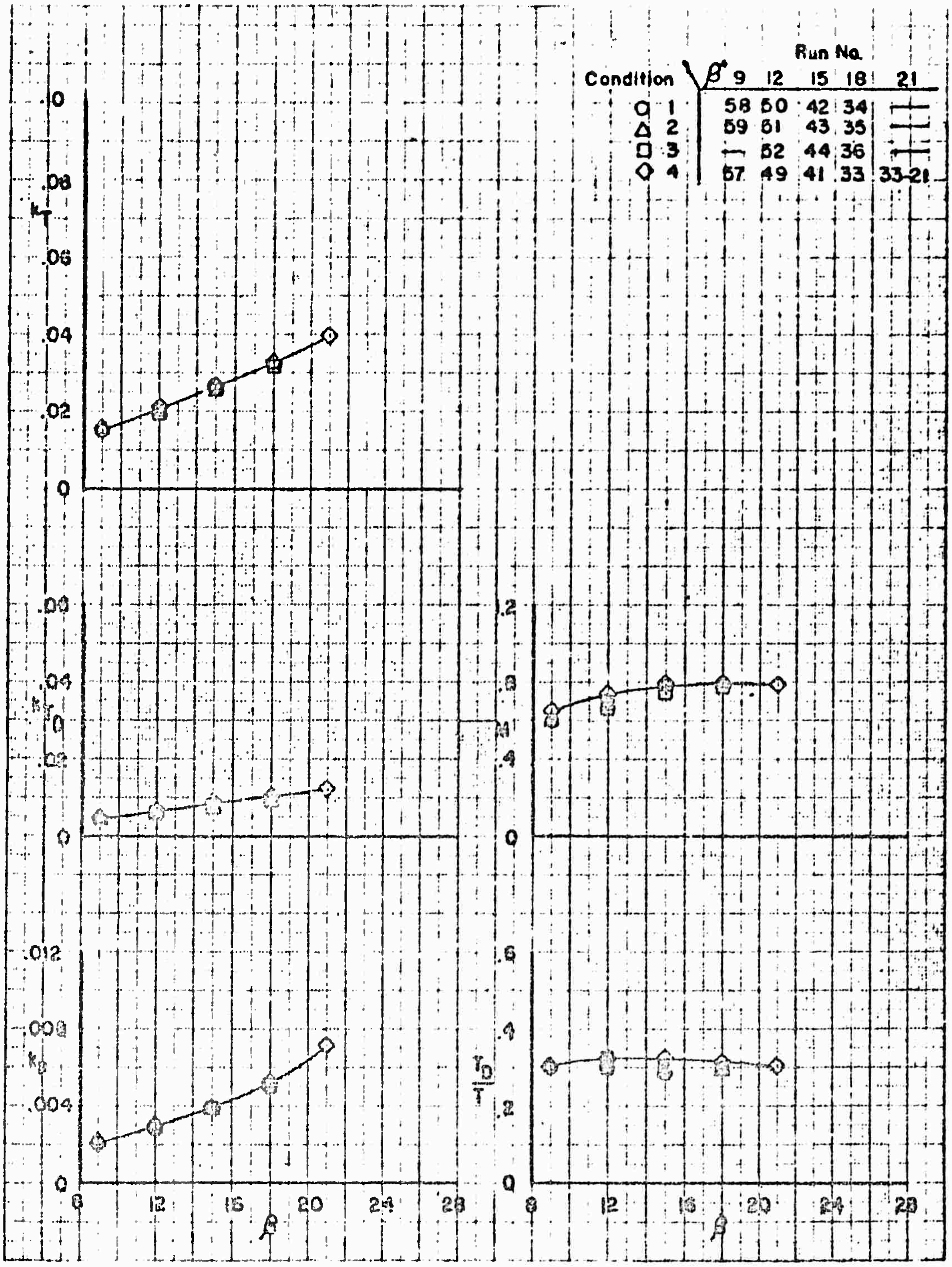


FIGURE 27 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

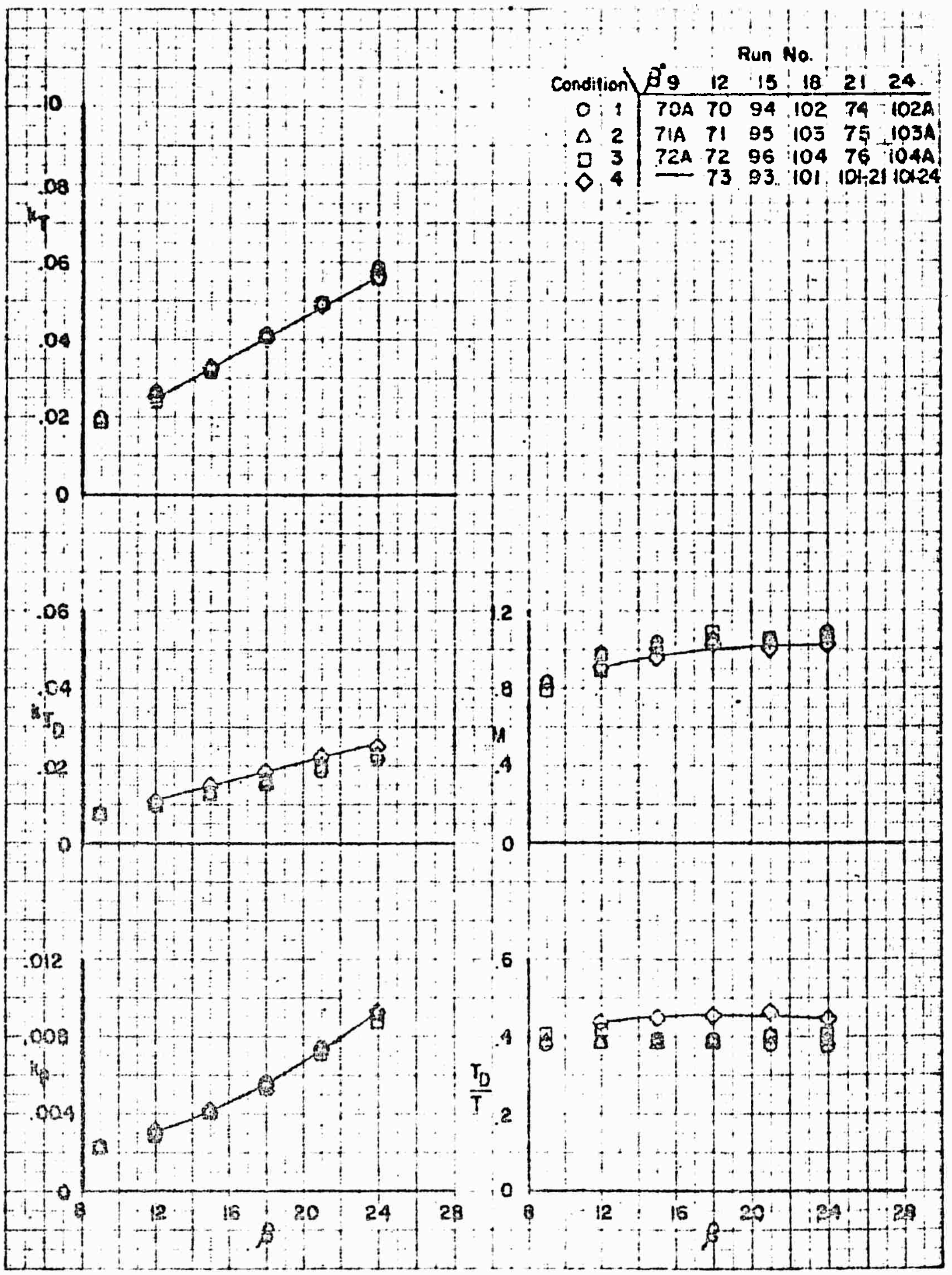


FIGURE 28 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

Condition	$\beta°$ 9	12	15	18	21
○ 1	138	130	122R	114R	—
△ 2	139	131	123	115	—
□ 3	140	132	124	116	—
◇ 4	137	129	121	113	113-21

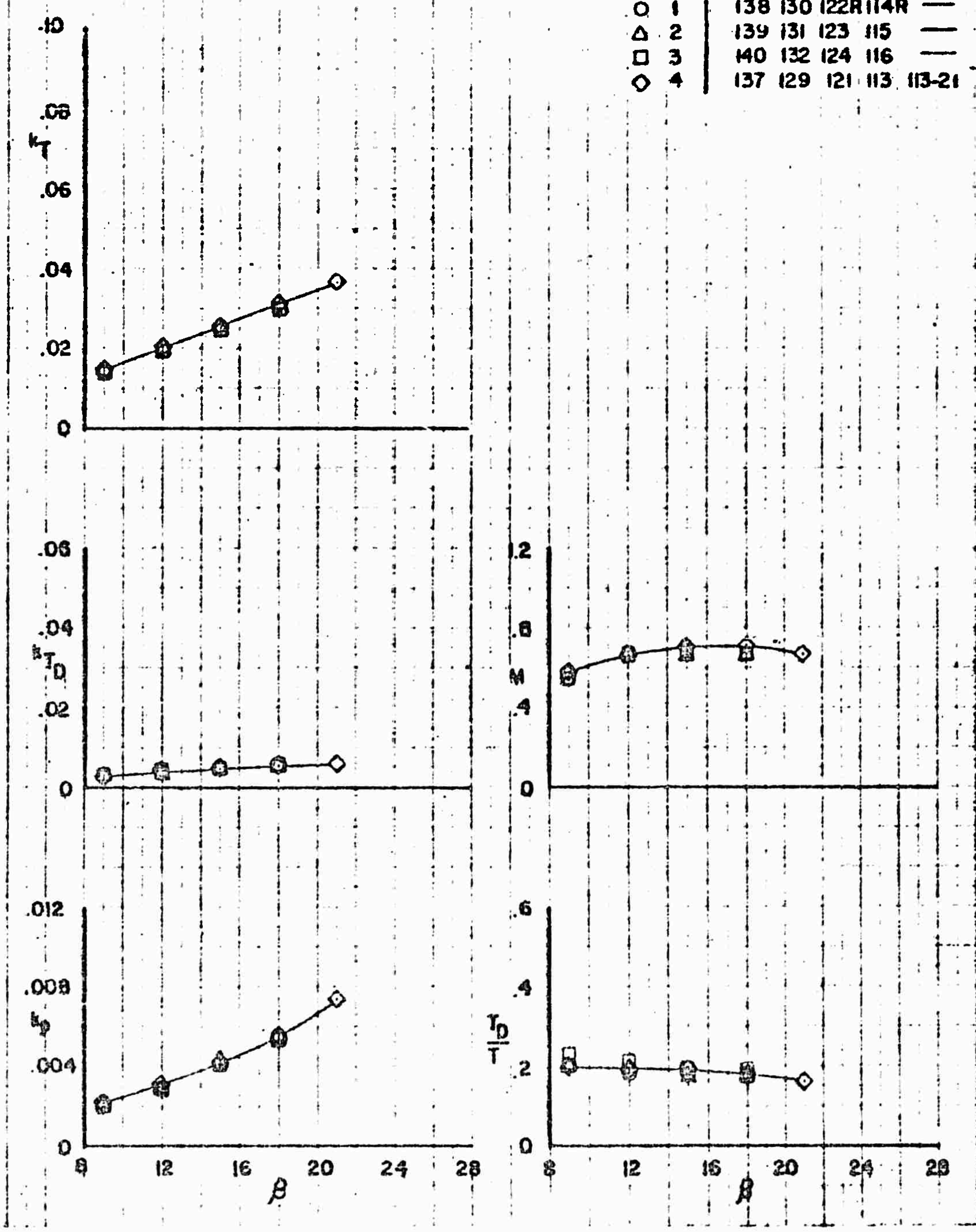


FIGURE 29 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_2S

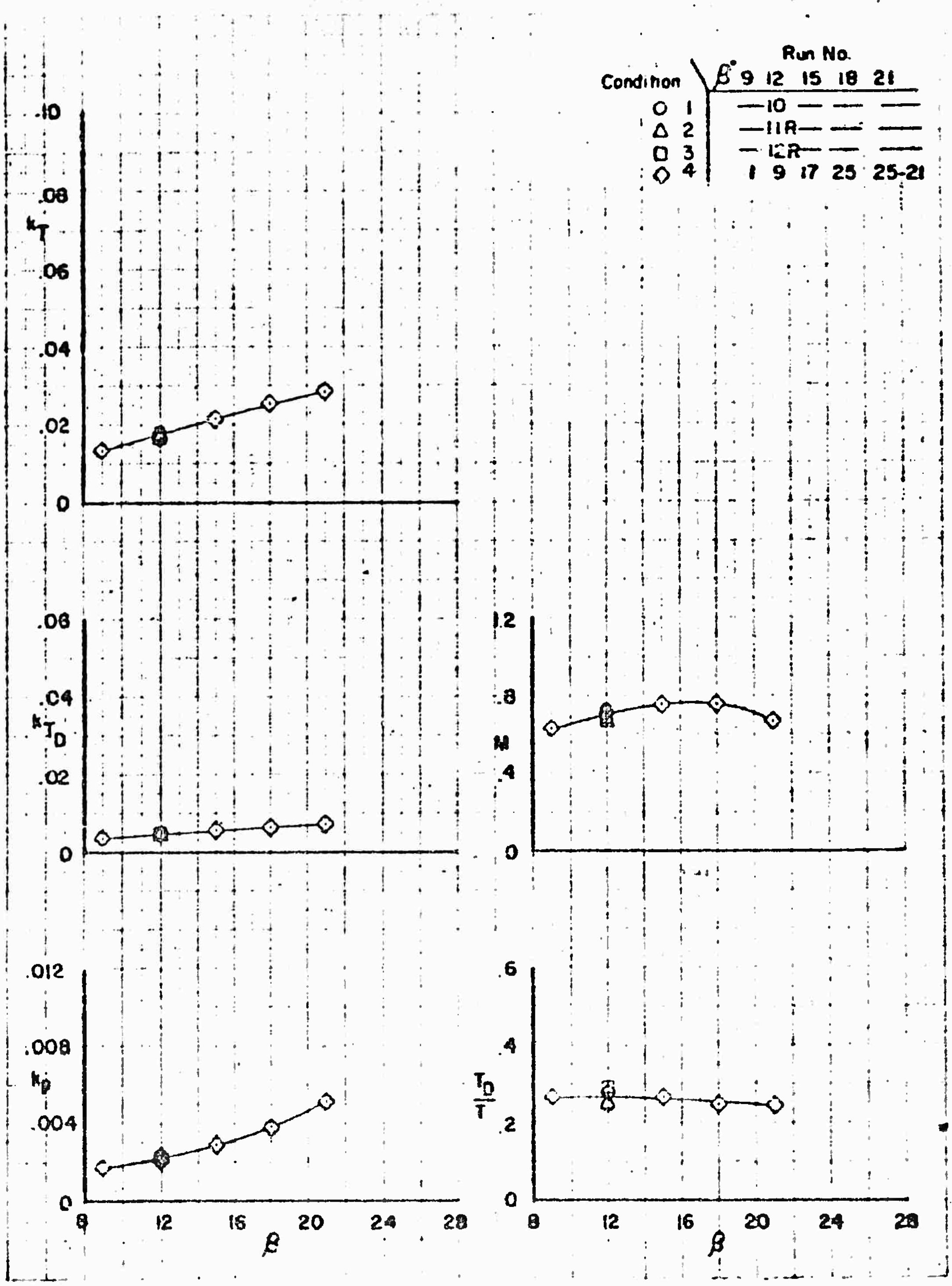


FIGURE 30 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_2S

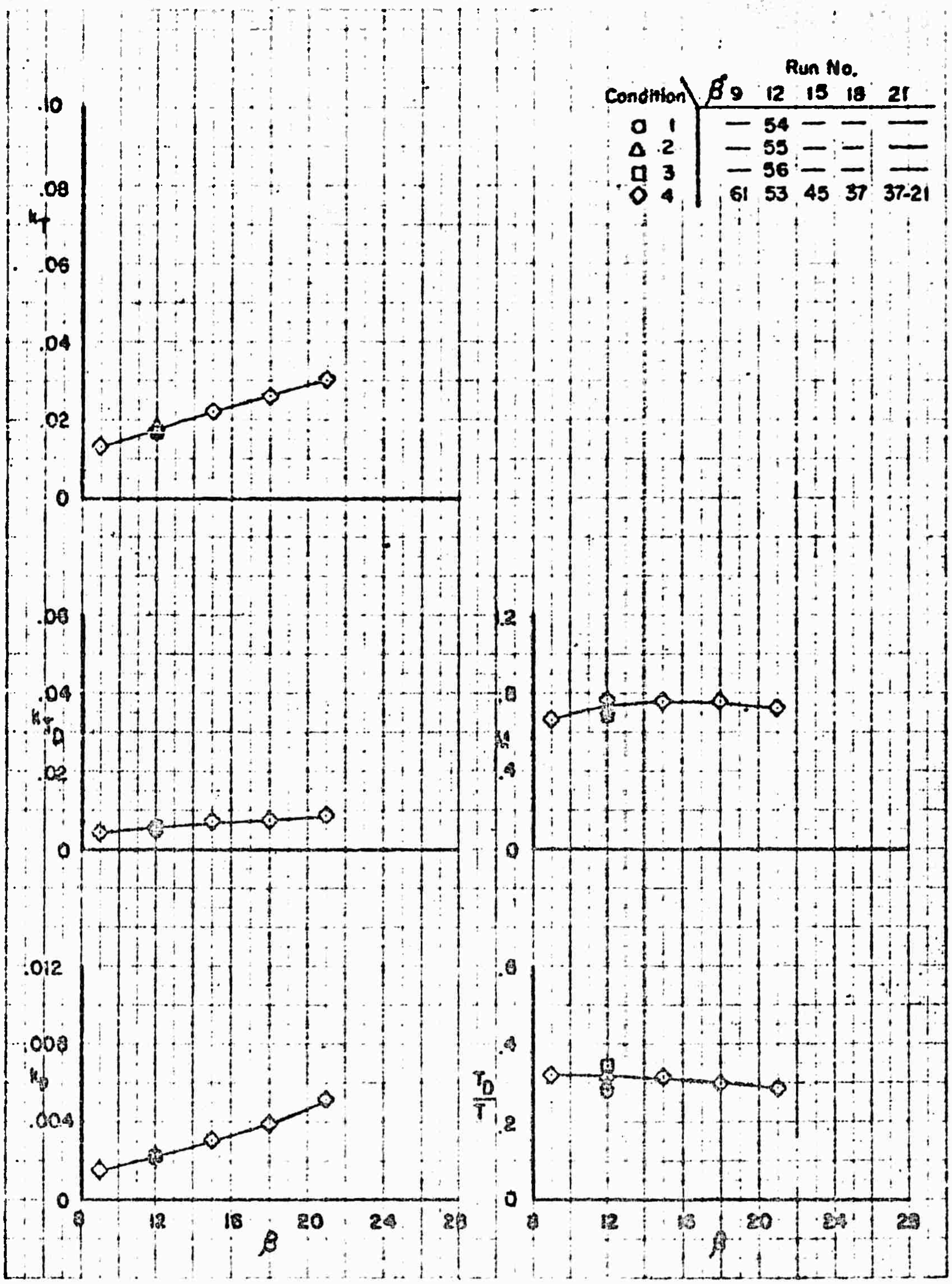


FIGURE 31 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S

Condition	$\beta°$ 9	12	15	18	21
○ 1	66	78	—	106	—
△ 2	67	79	—	107	—
□ 3	—	80	—	108	—
◇ 4	—	77	97	105	105-21

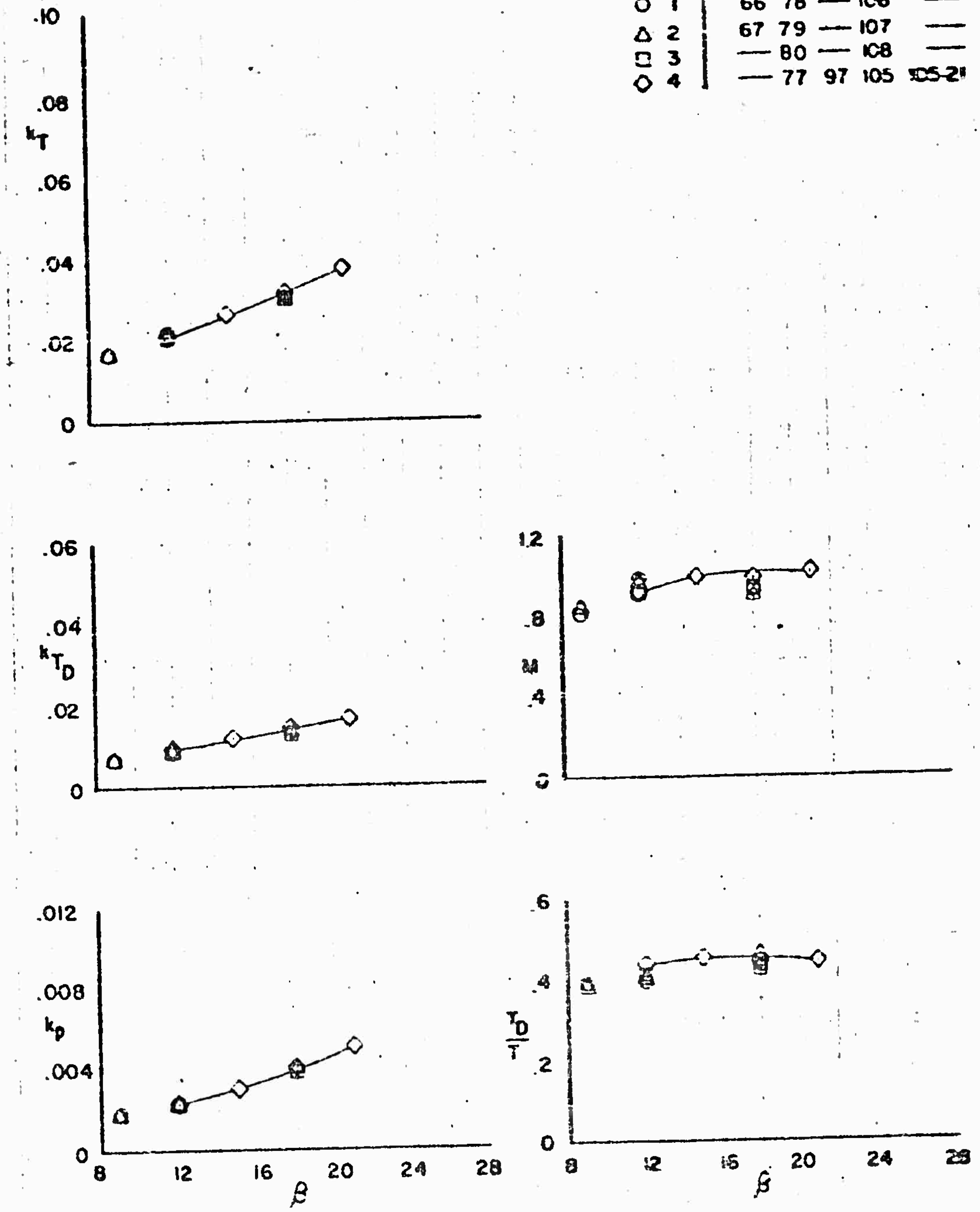


FIGURE 32 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (OO) Phase IV

Configuration D_4P_2S

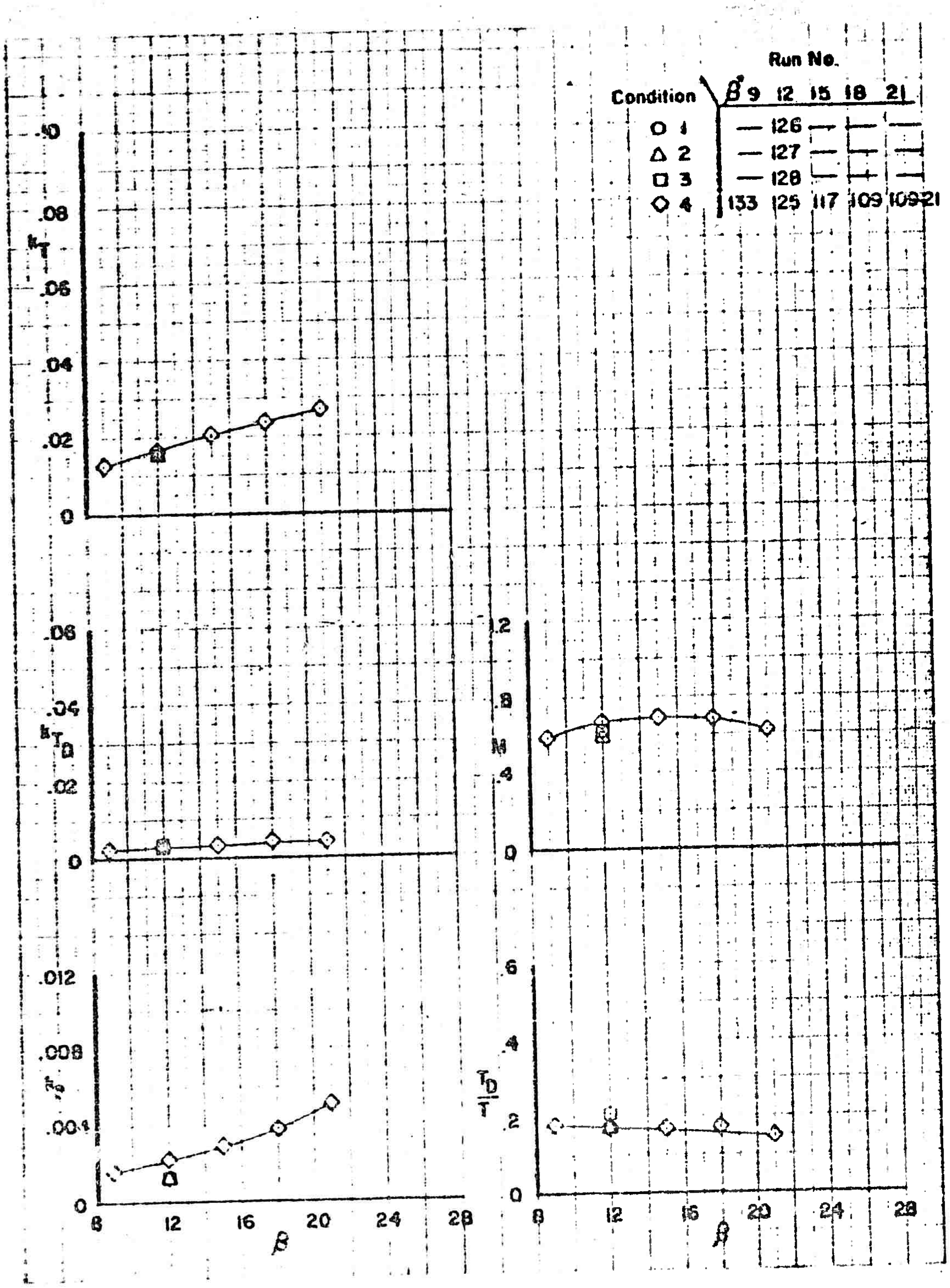


FIGURE 33 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_pS

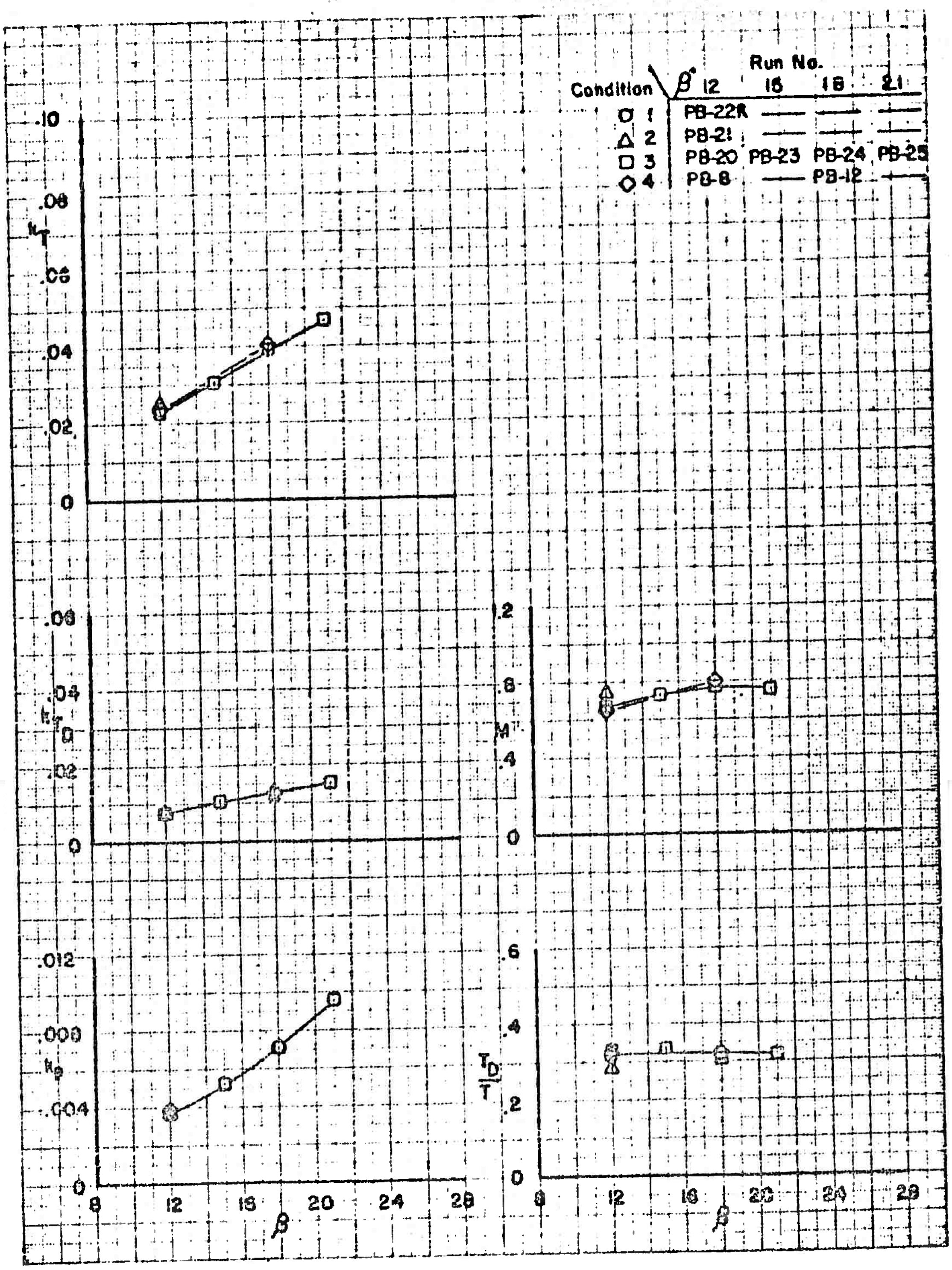


FIGURE 34 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_pS

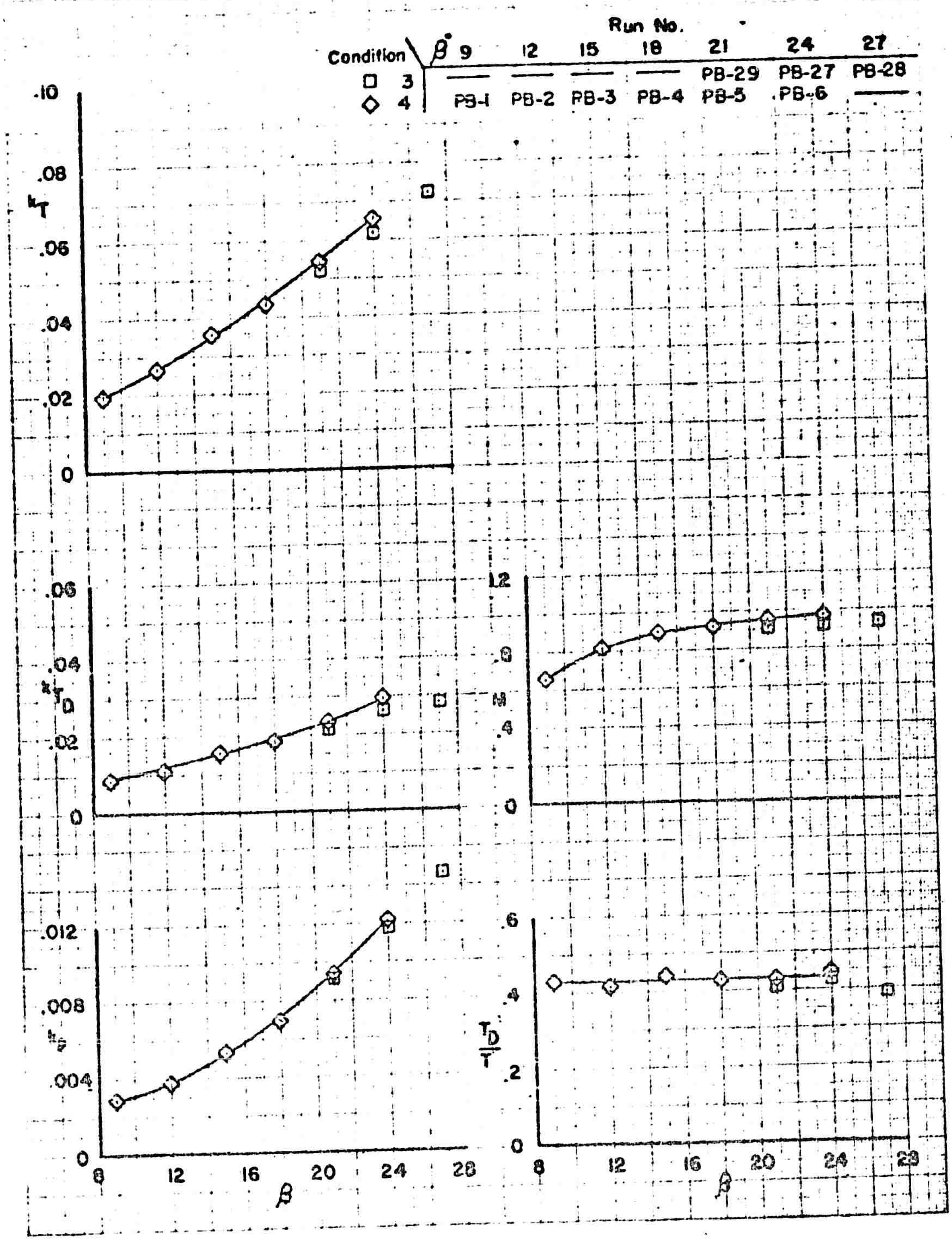


FIGURE 35 VARIATION OF PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration P_3S

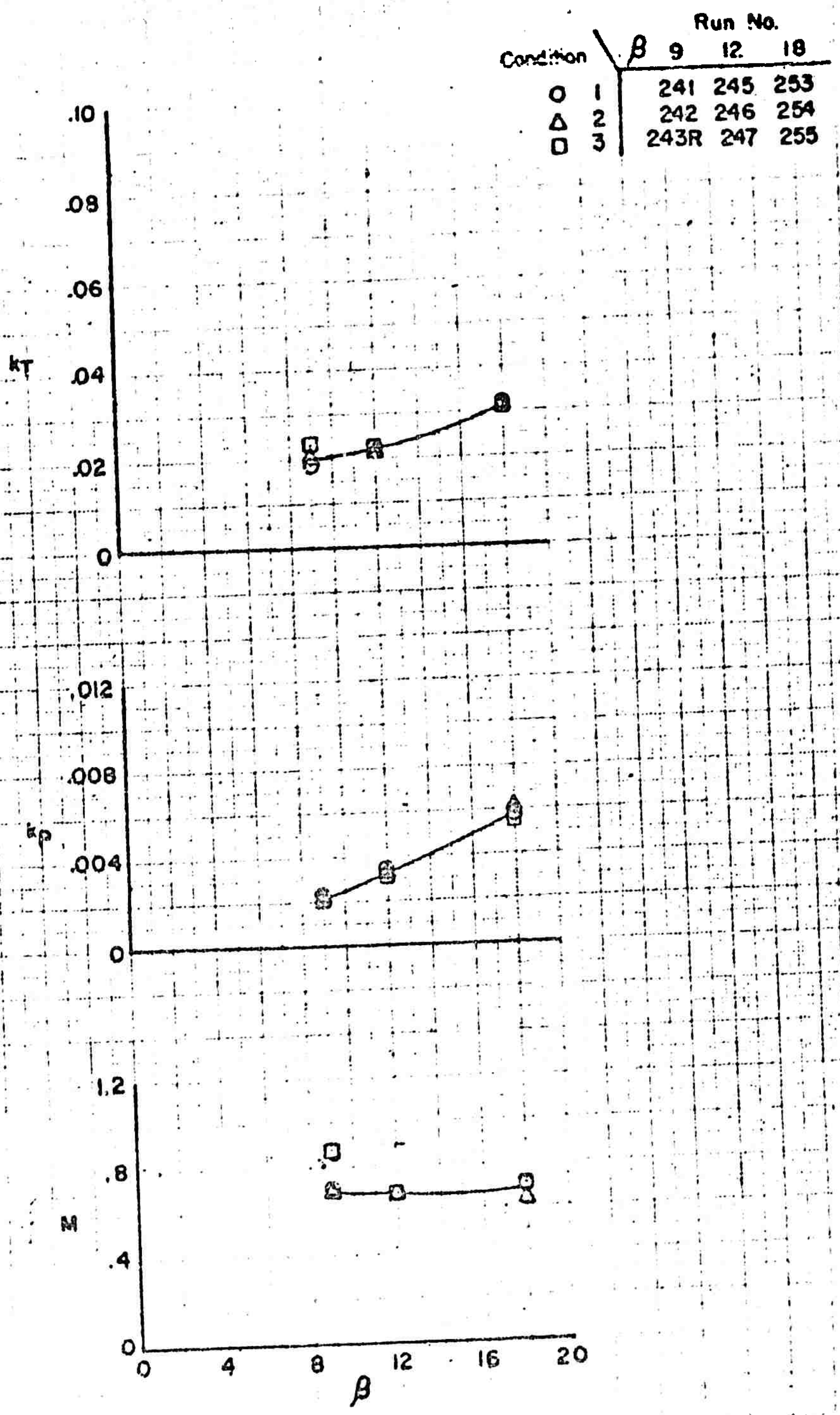
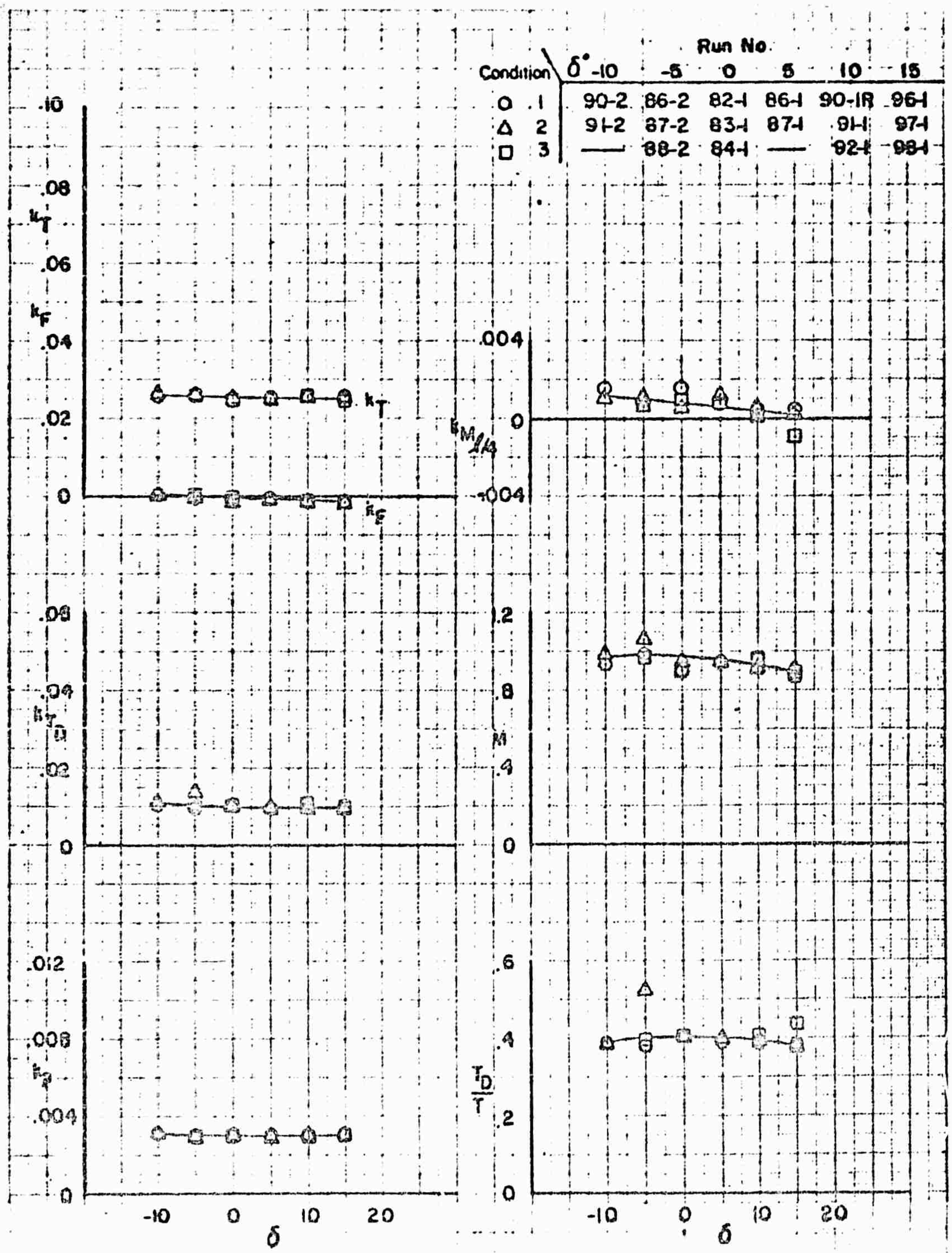


FIGURE 36 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3SV

$\beta = 12°$



Condition \ $\delta°$	-10	-5	0	5	10	15
○ 1	90-2	86-2	82-1	86-1	90-1R	96-1
△ 2	91-2	87-2	83-1	87-1	91-1	97-1
□ 3	—	88-2	84-1	—	92-1	98-1

(Run No.)

FIGURE 37 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3H

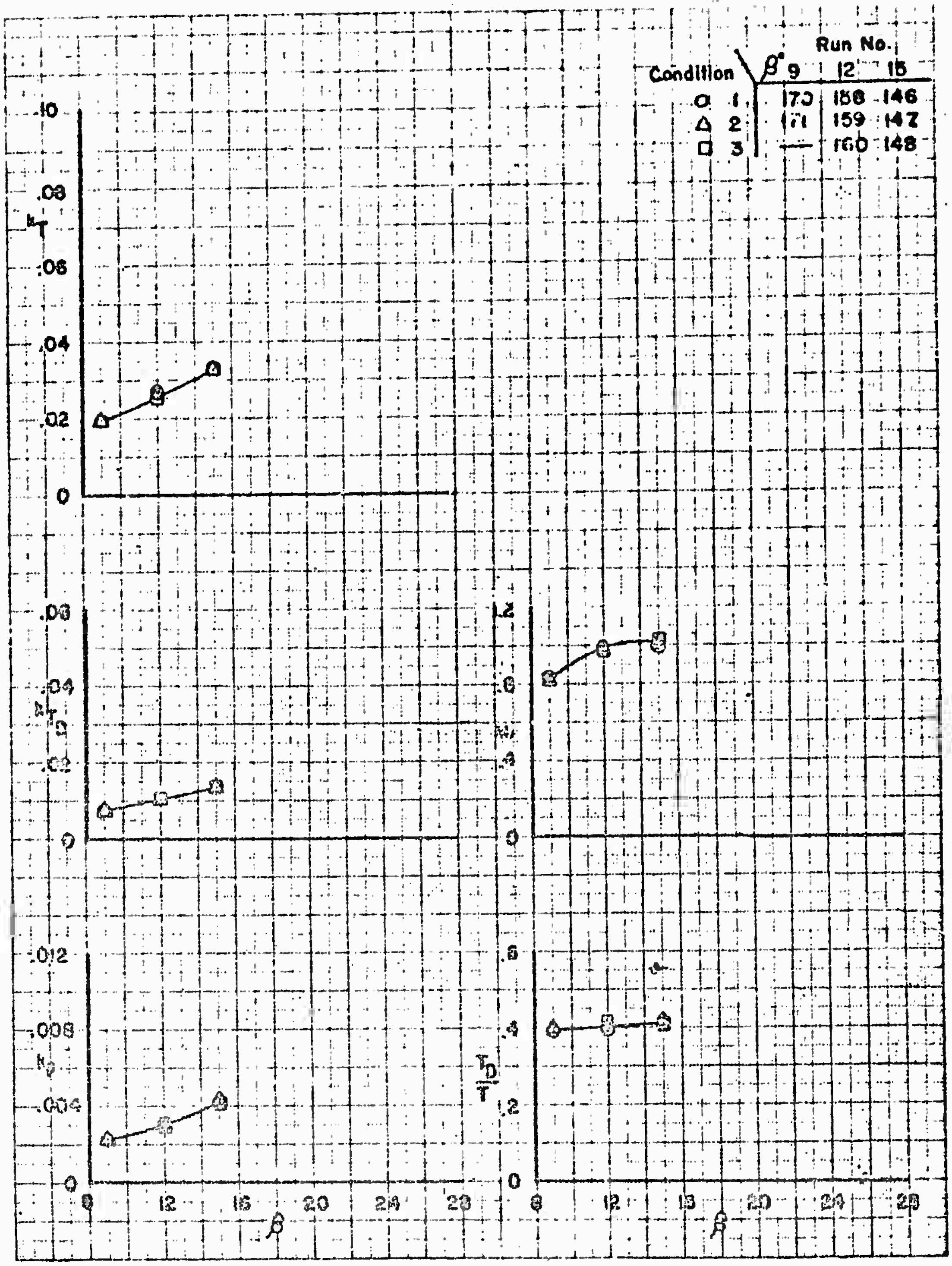


FIGURE 38 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3HB

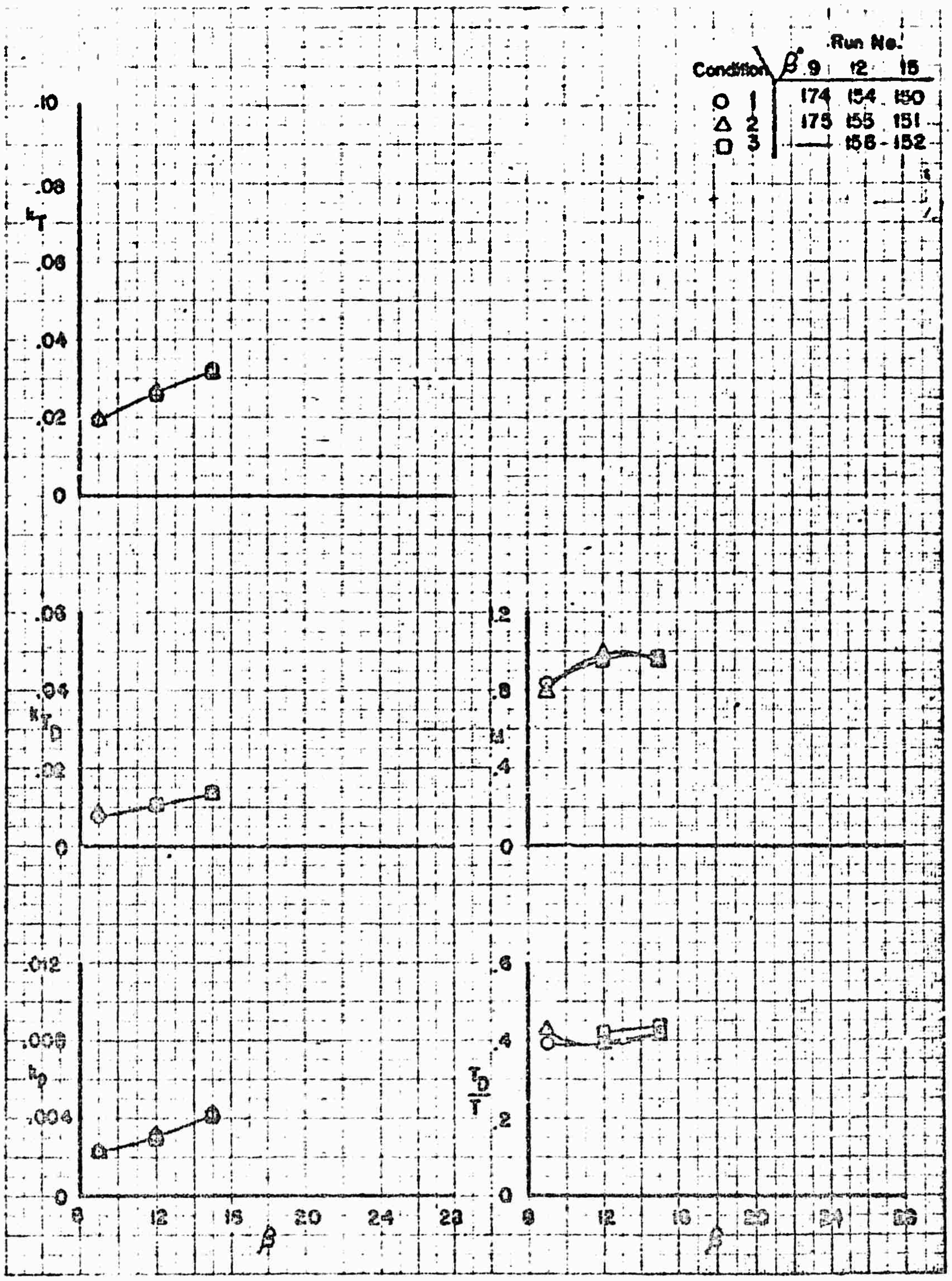


FIGURE 39 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

$\Delta R = .088$
$\ell_p = 5.13$

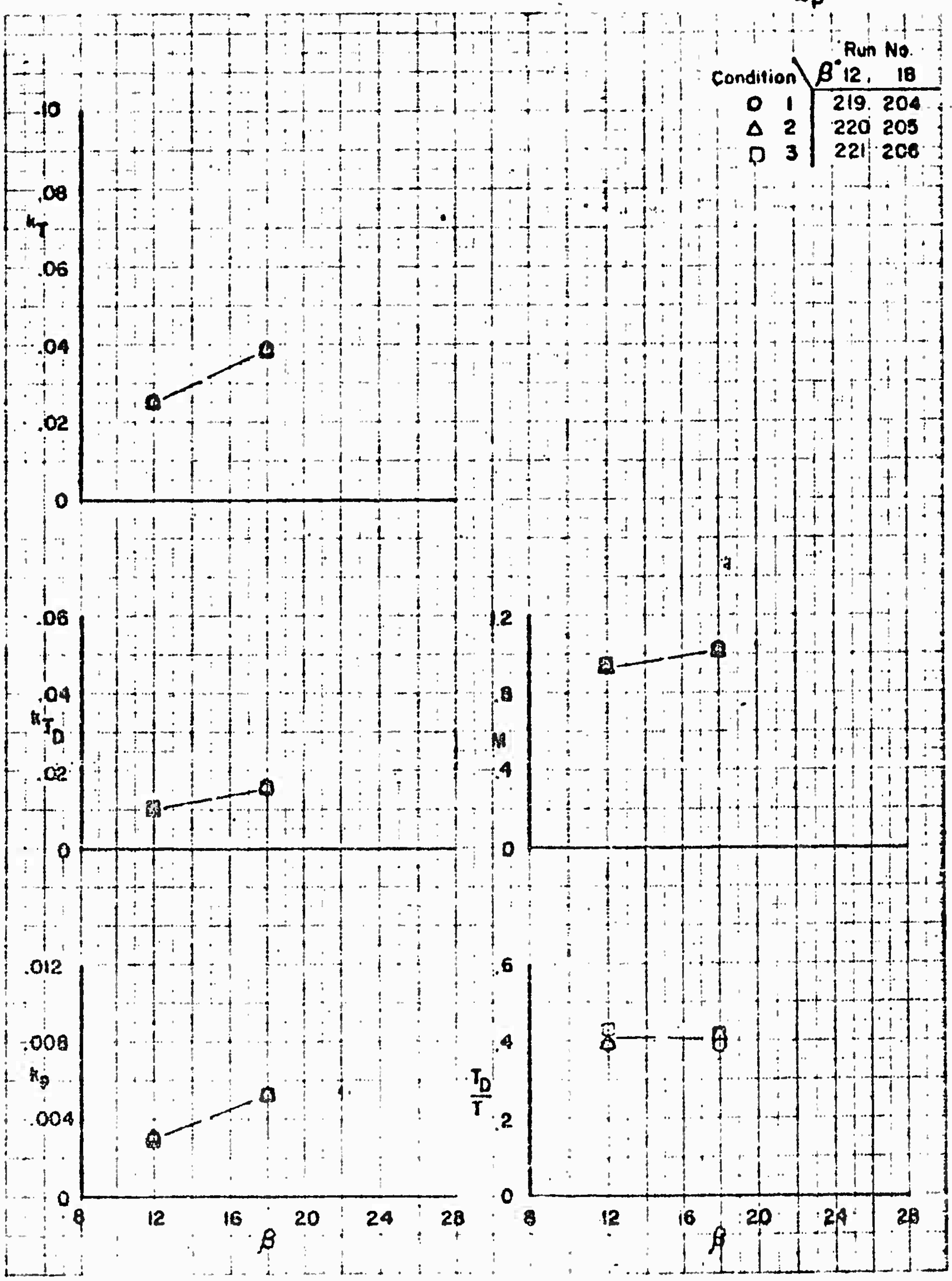


FIGURE 40 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

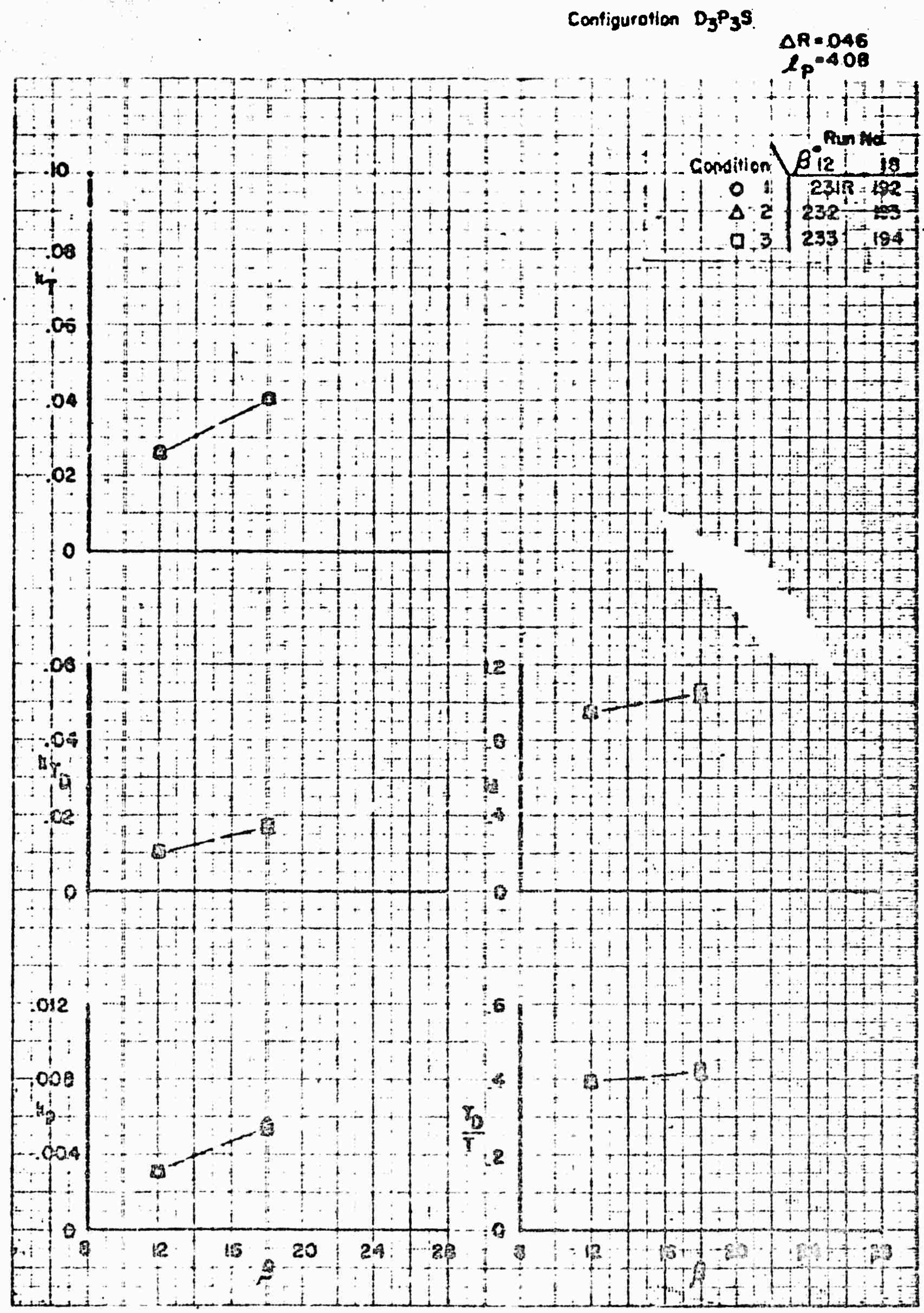


FIGURE 41 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

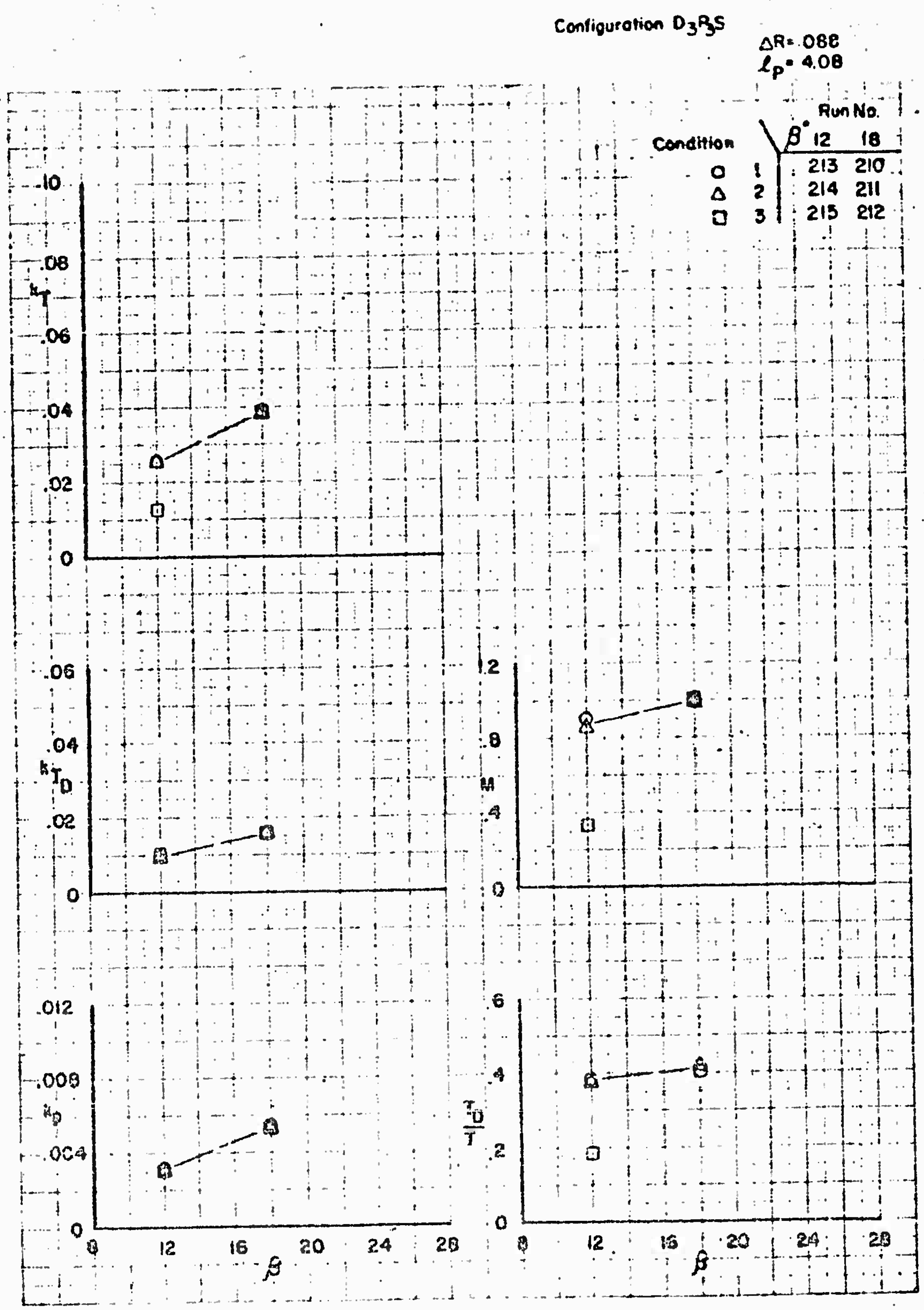


FIGURE 42 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH BLADE ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

$\Delta R = .046$

$\ell_p = 2.58$

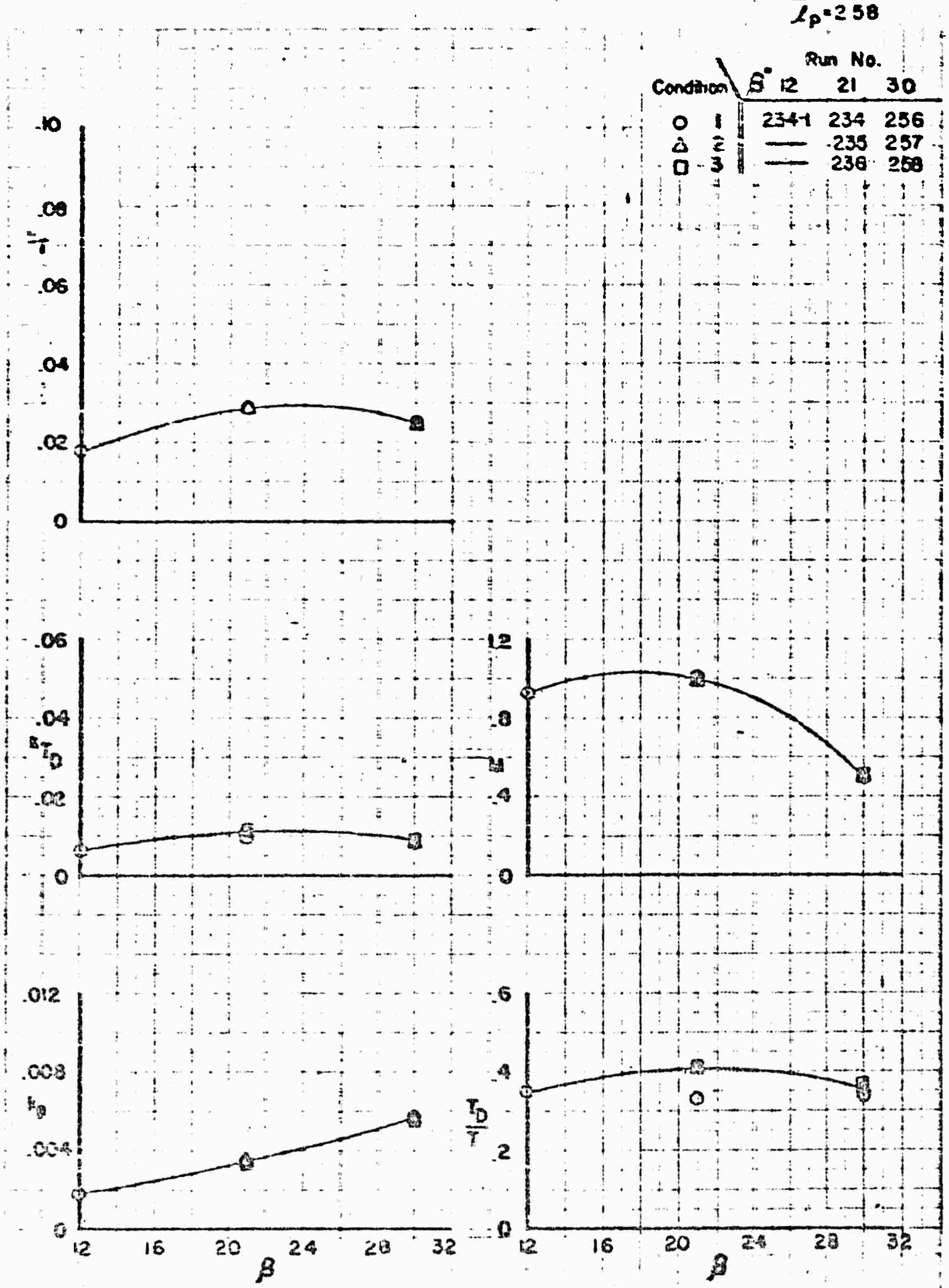


FIGURE 43 VARIATION OF DUCTED PROPELLER STATIC FORCE AND POWER COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

$\beta = 12$

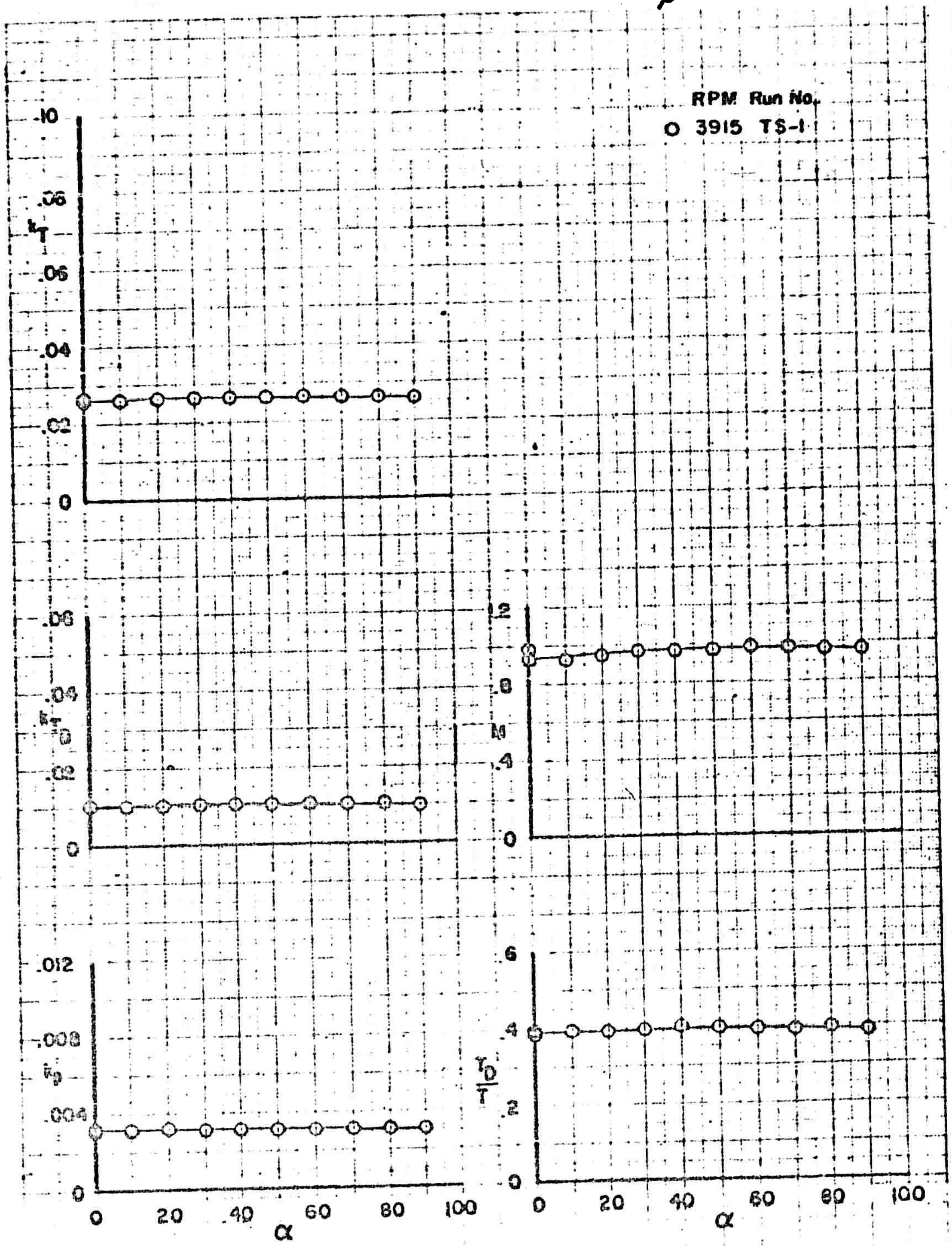


FIGURE 44a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_1 P_3 S$

$\beta = 9°$

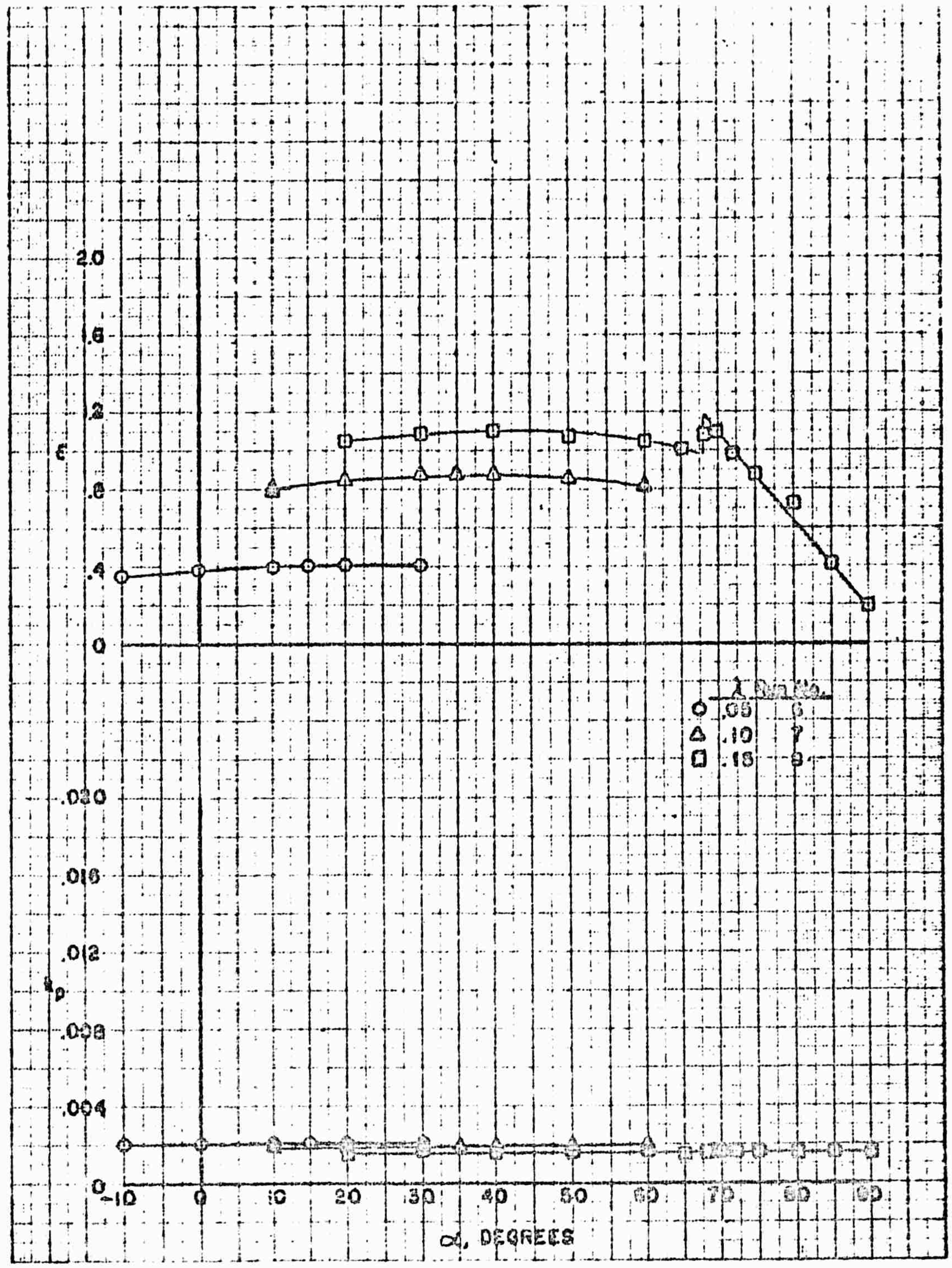


FIGURE 44b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

$\beta = 9°$

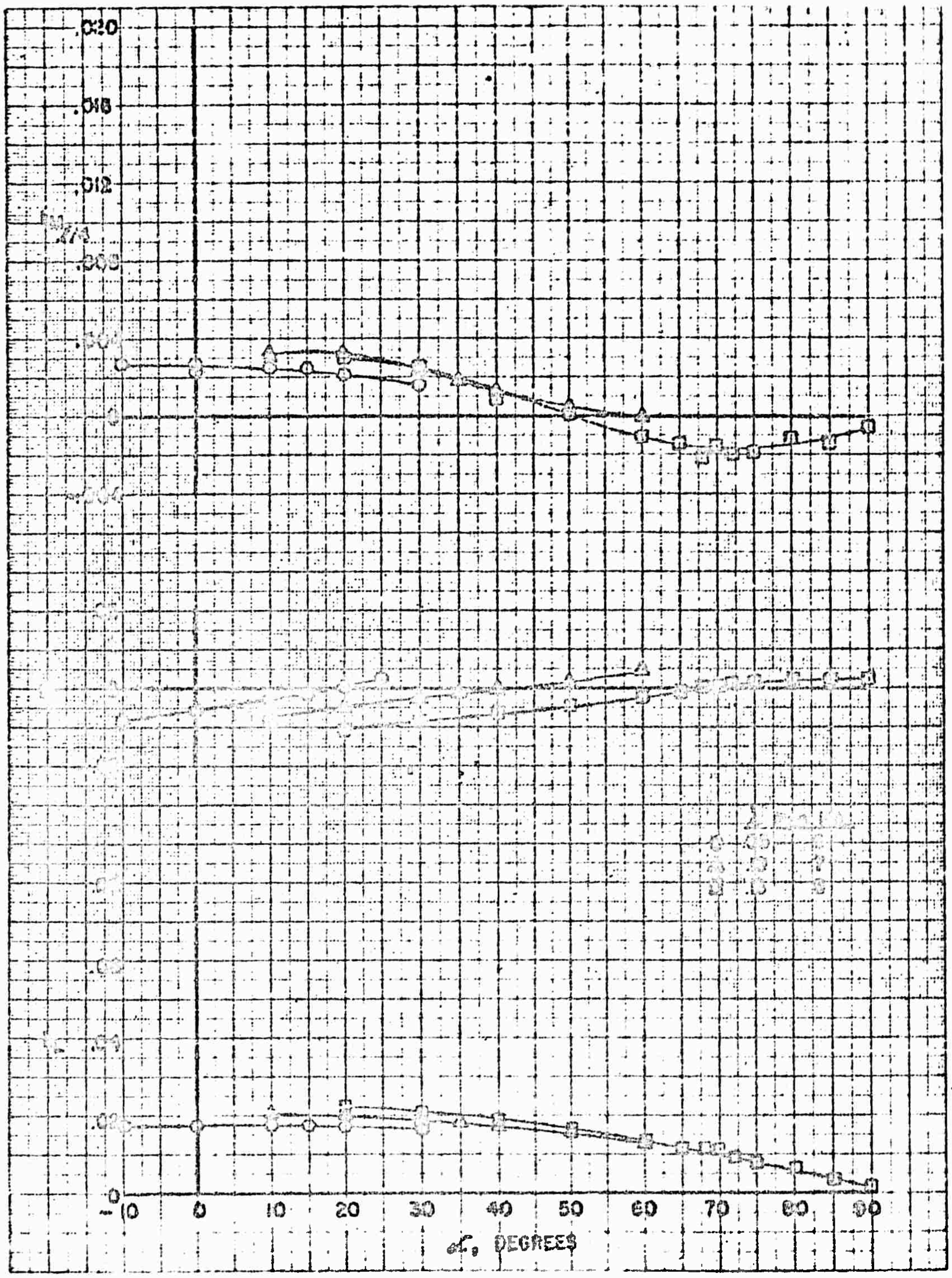


FIGURE 45a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

$\beta = 12°$

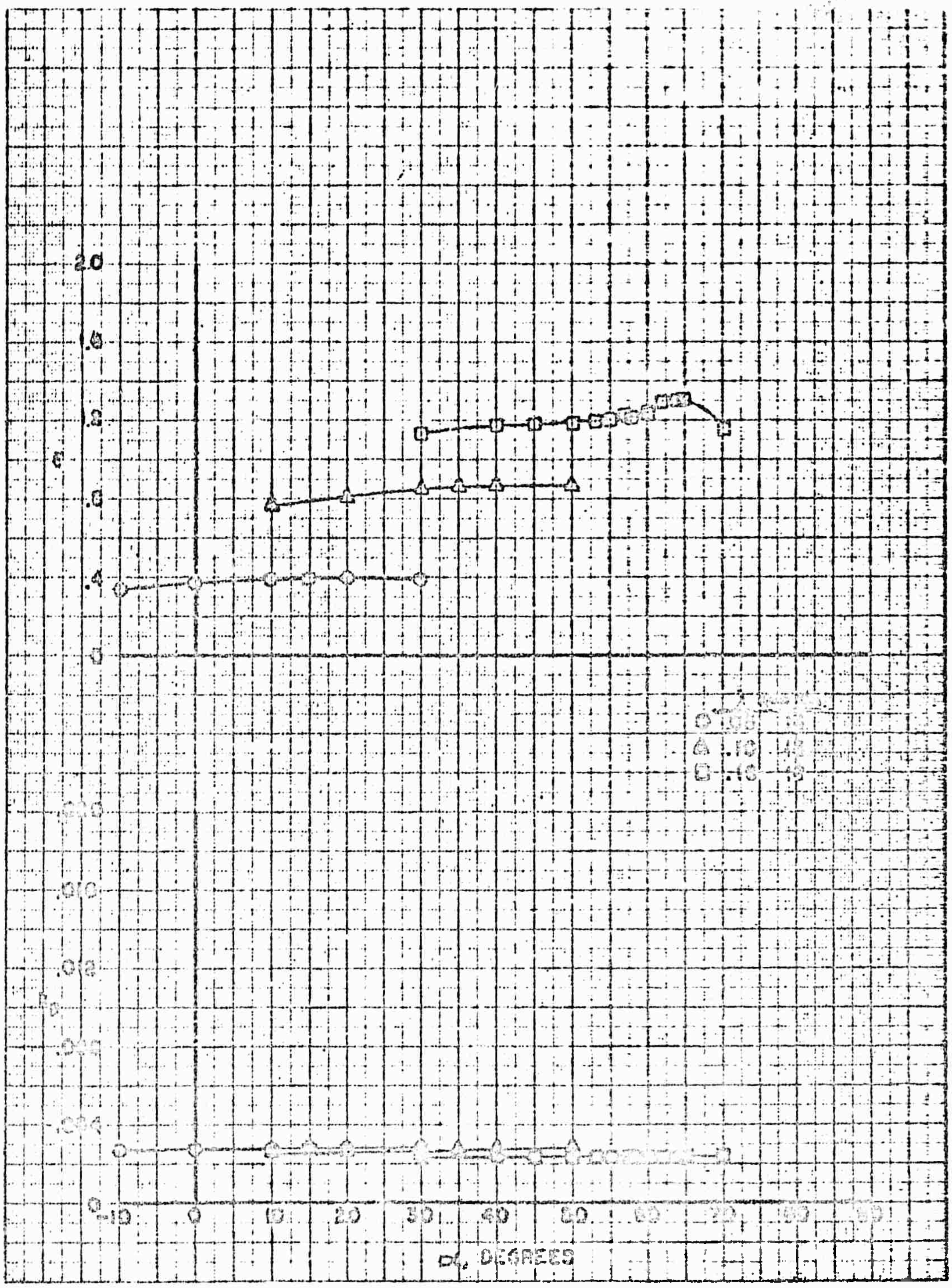


FIGURE 45b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

$\beta = 12°$

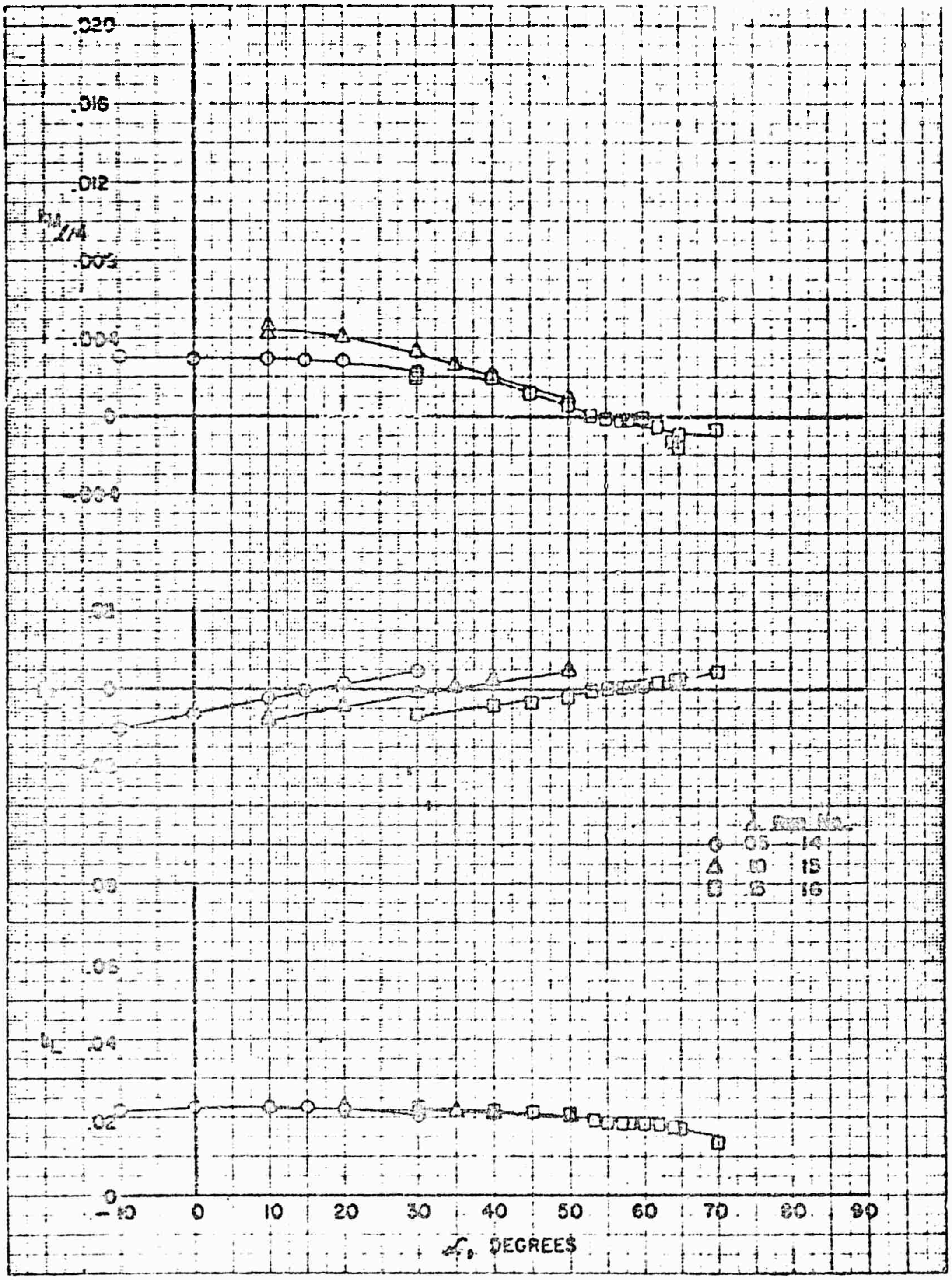


FIGURE 46a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

$\beta = 15°$

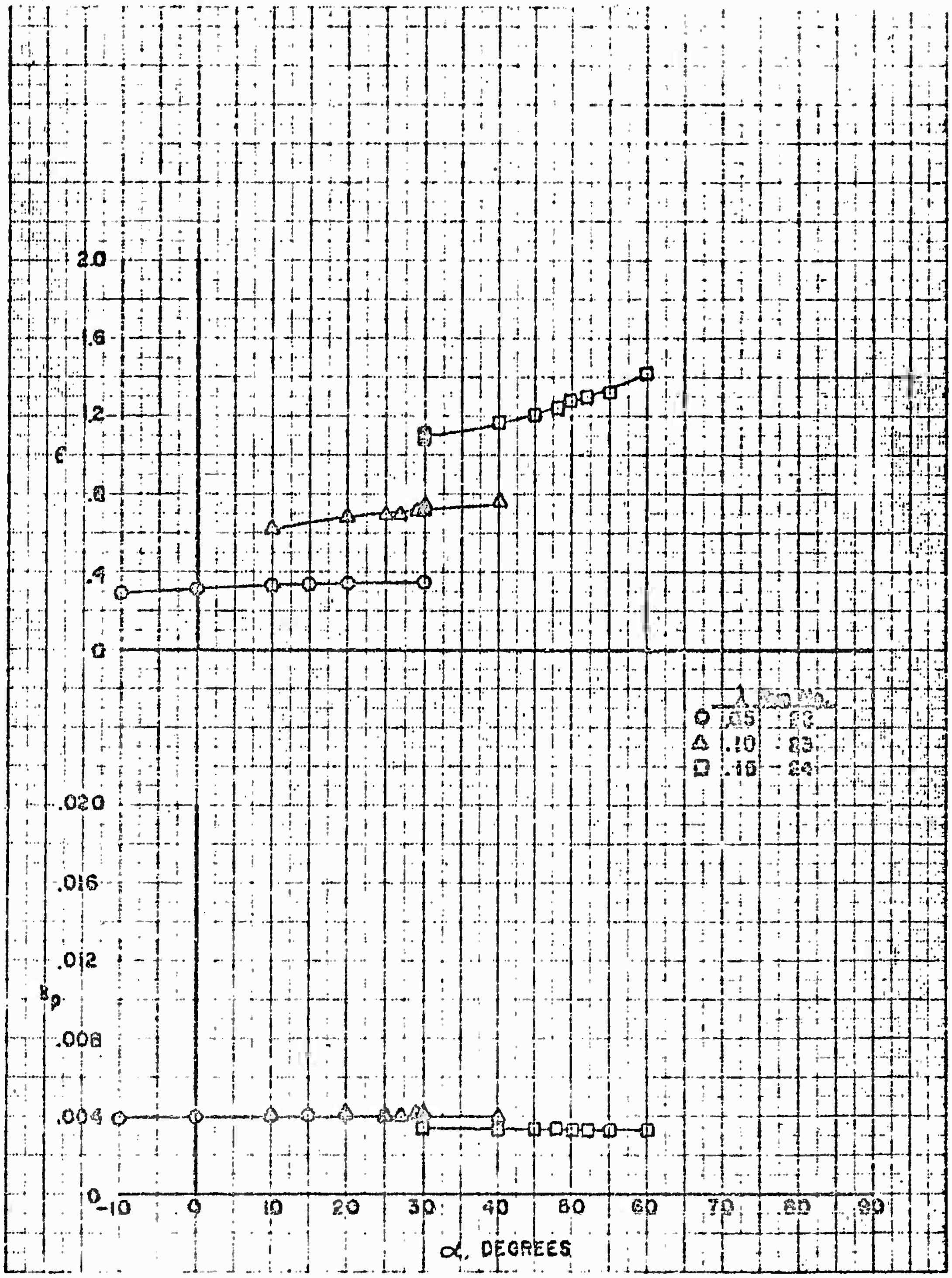


FIGURE 46b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_1 P_3 S$

$\beta = 15°$

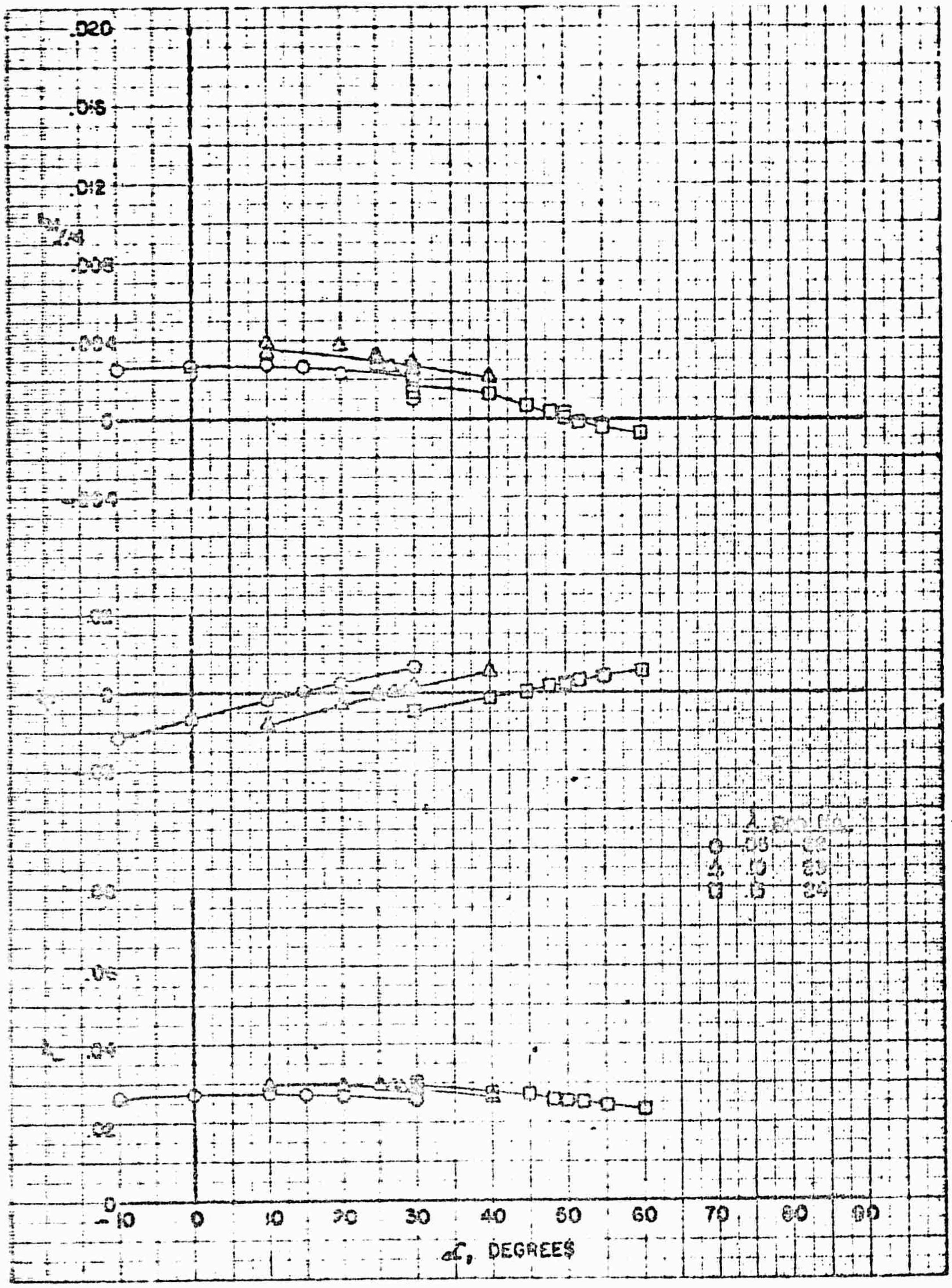


FIGURE 47a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

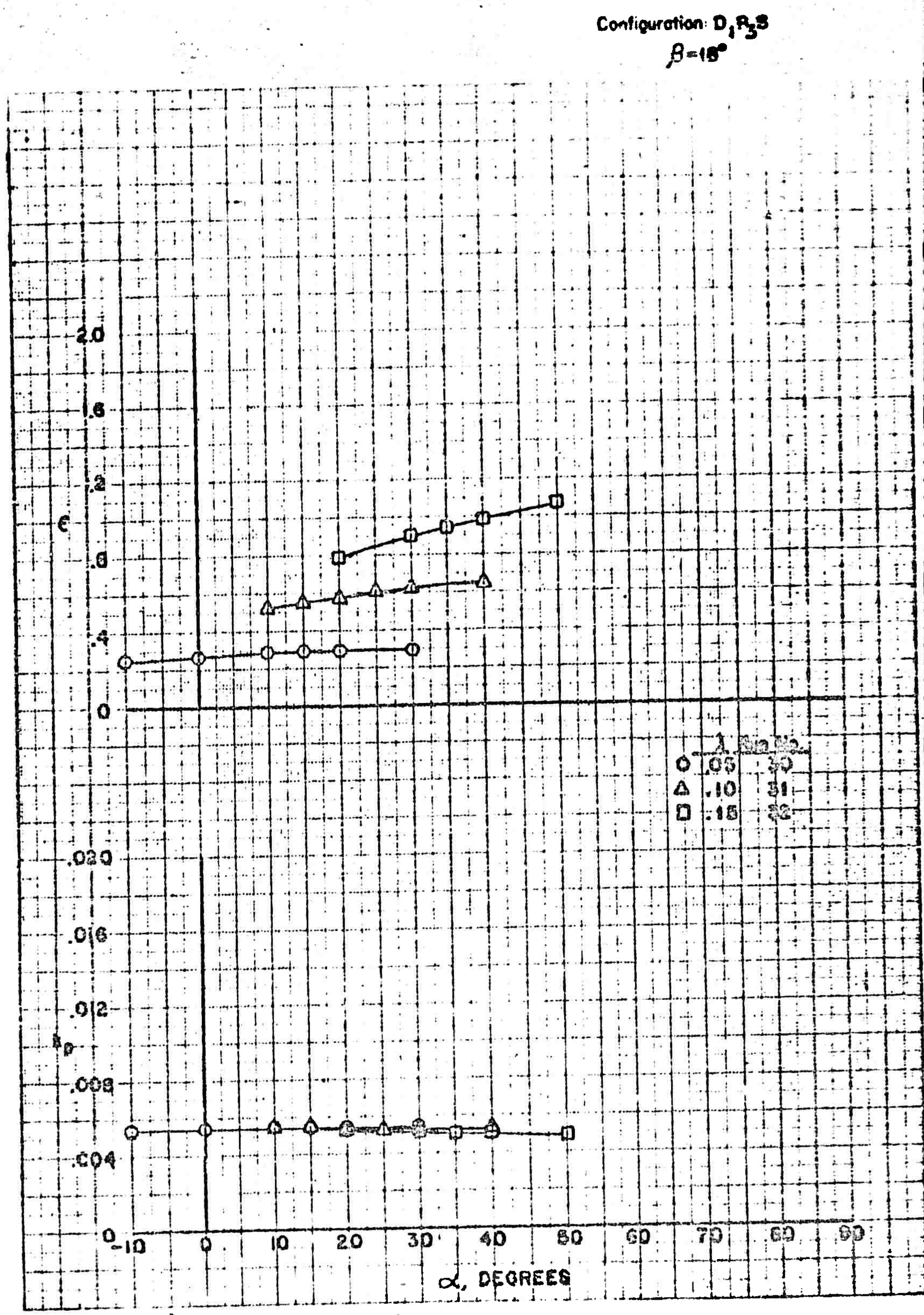


FIGURE 47b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_1 P_3 S$

$\beta = 18°$

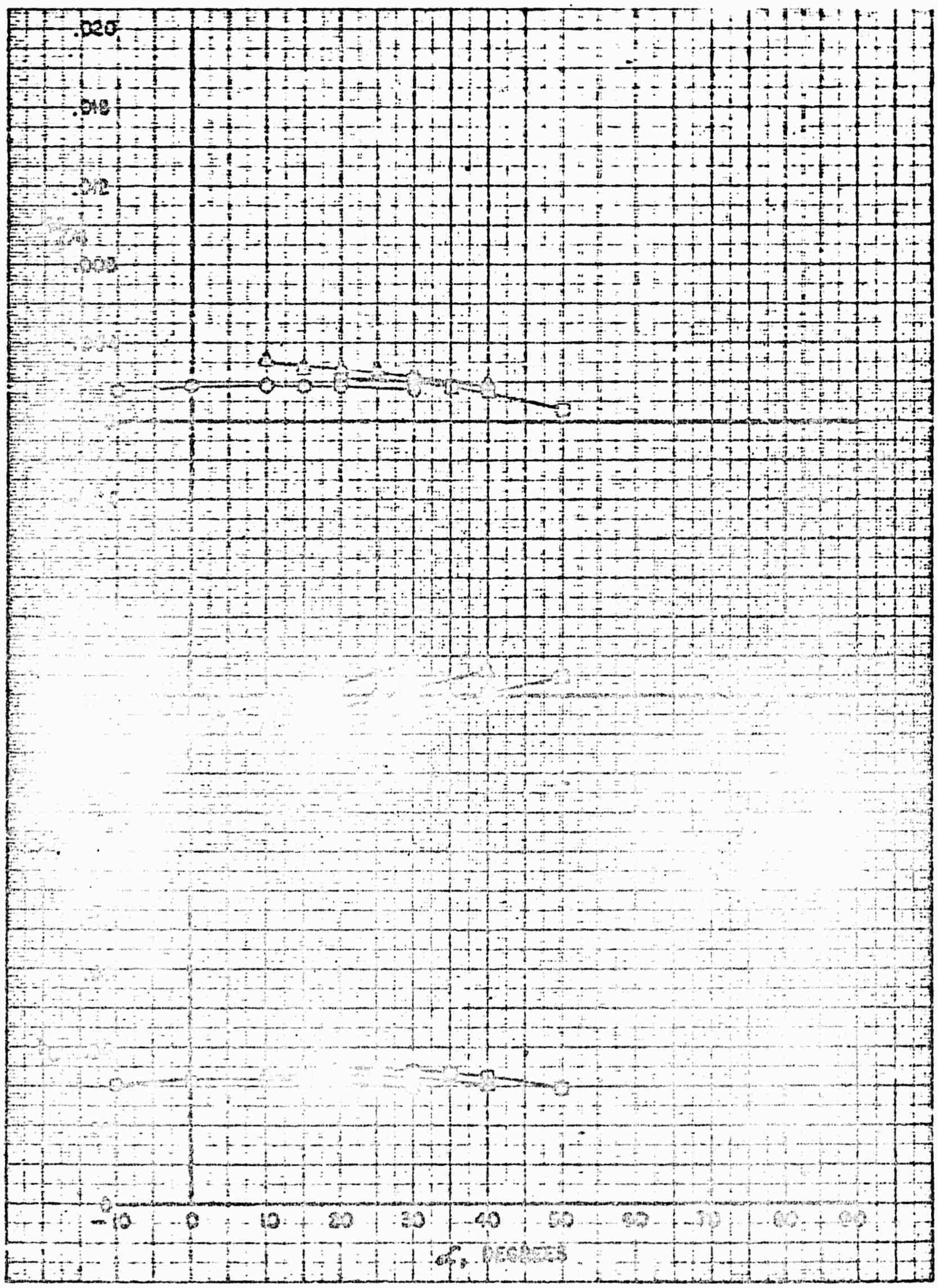


FIGURE 48a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_2P_3S

$\beta = 9°$

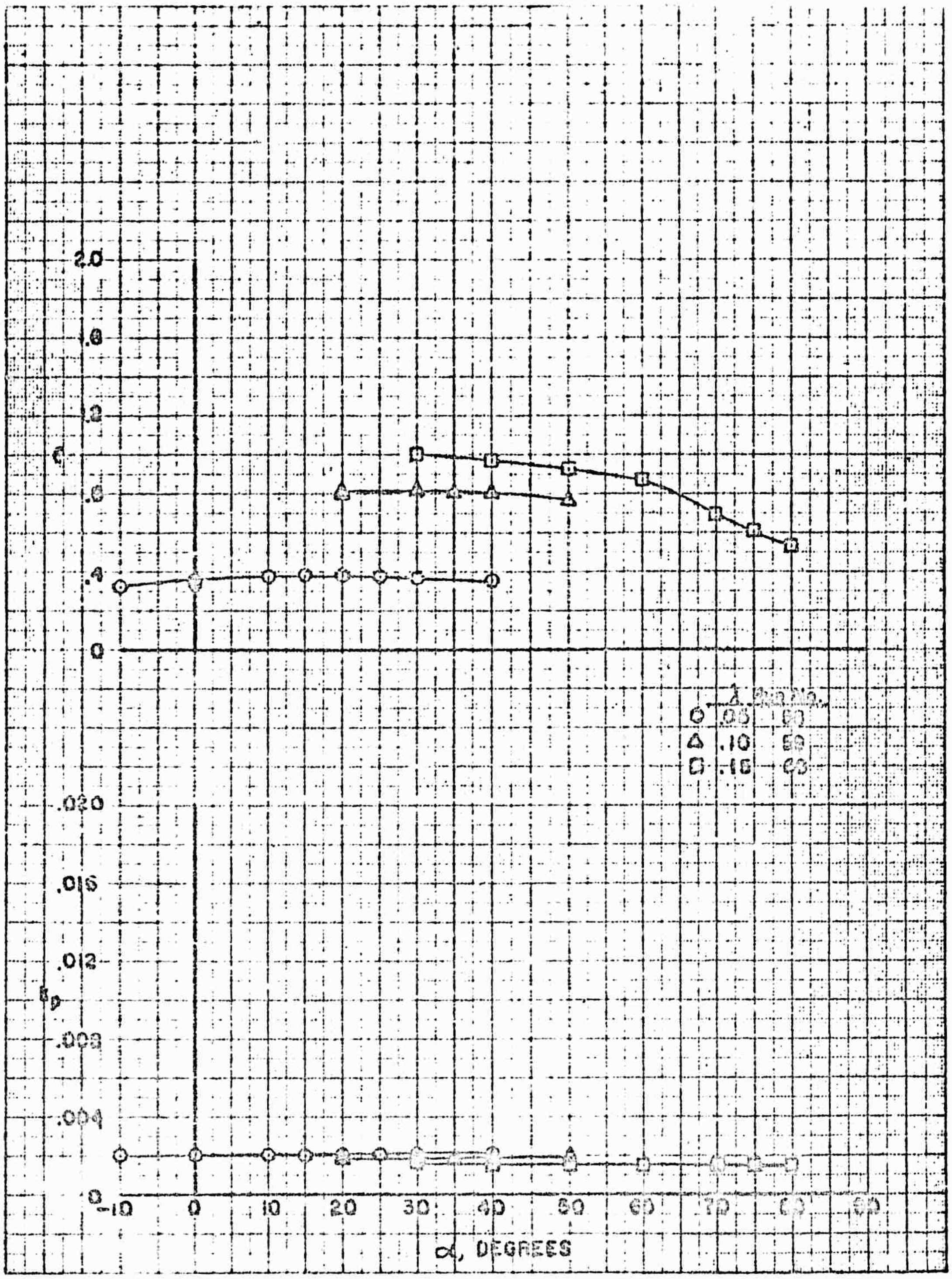


FIGURE 48b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_2 P_3 S$

$\beta = 9°$

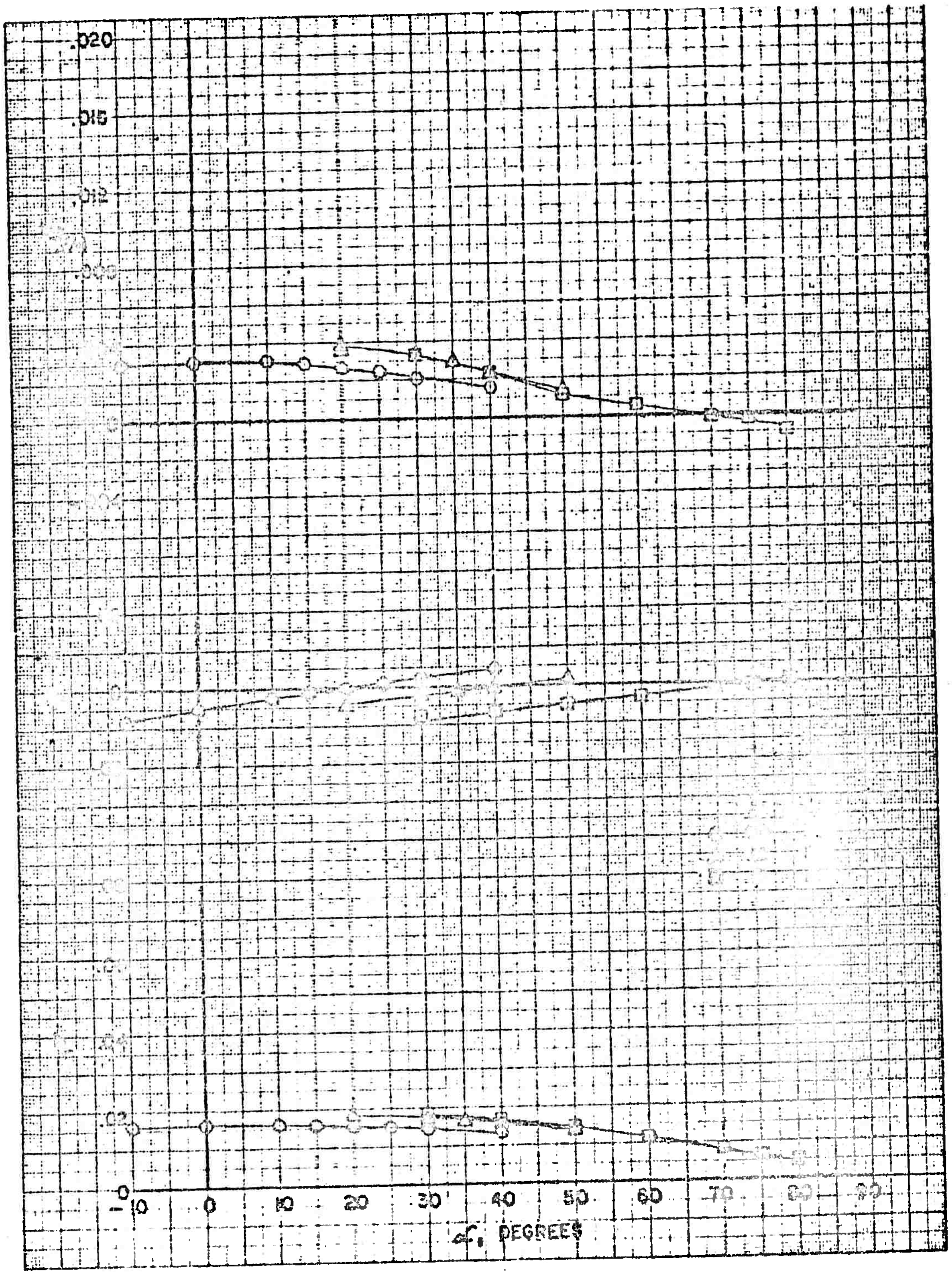


FIGURE 49a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_3S

$\beta = 12°$

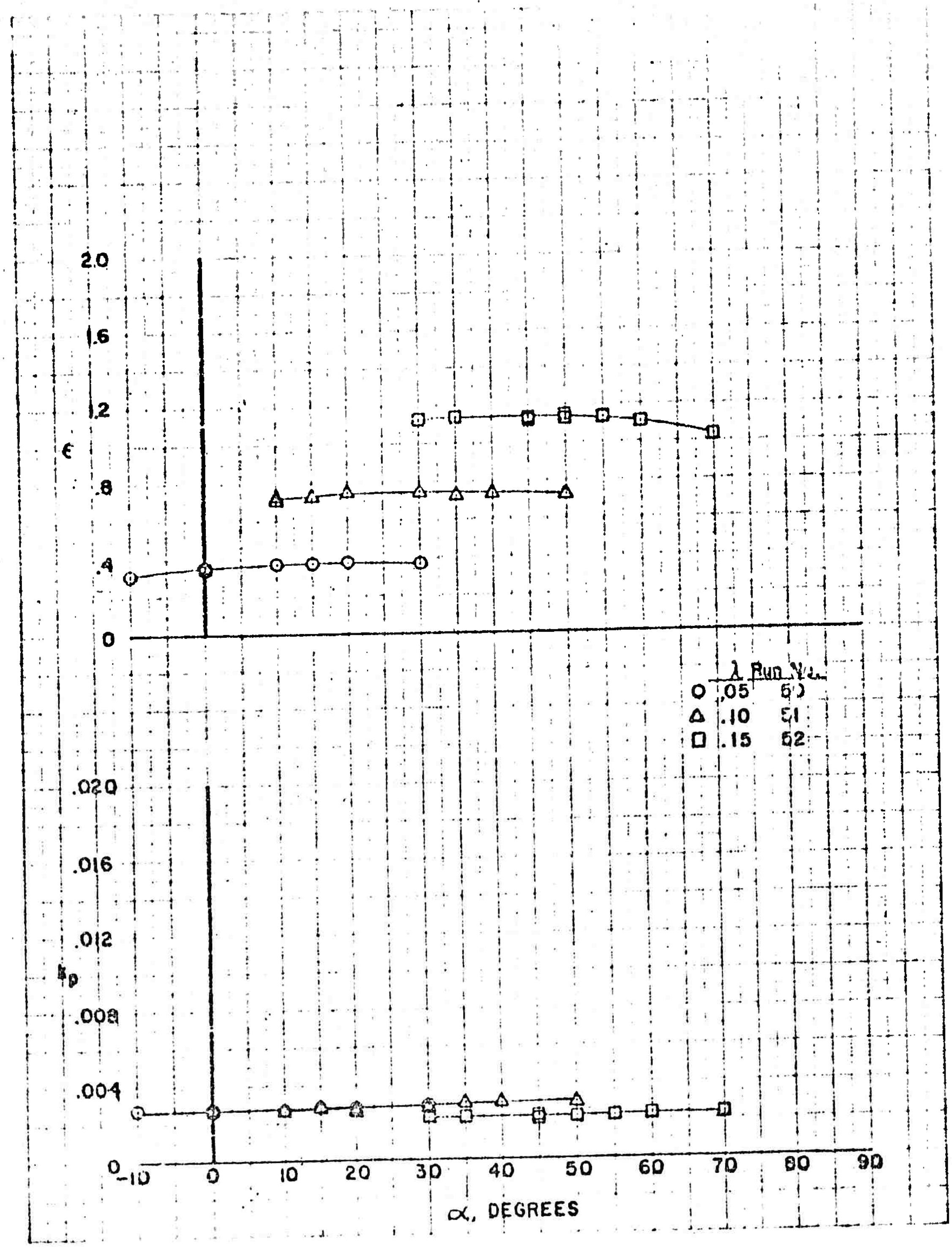


FIGURE 49b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_3S

$\beta = 12°$

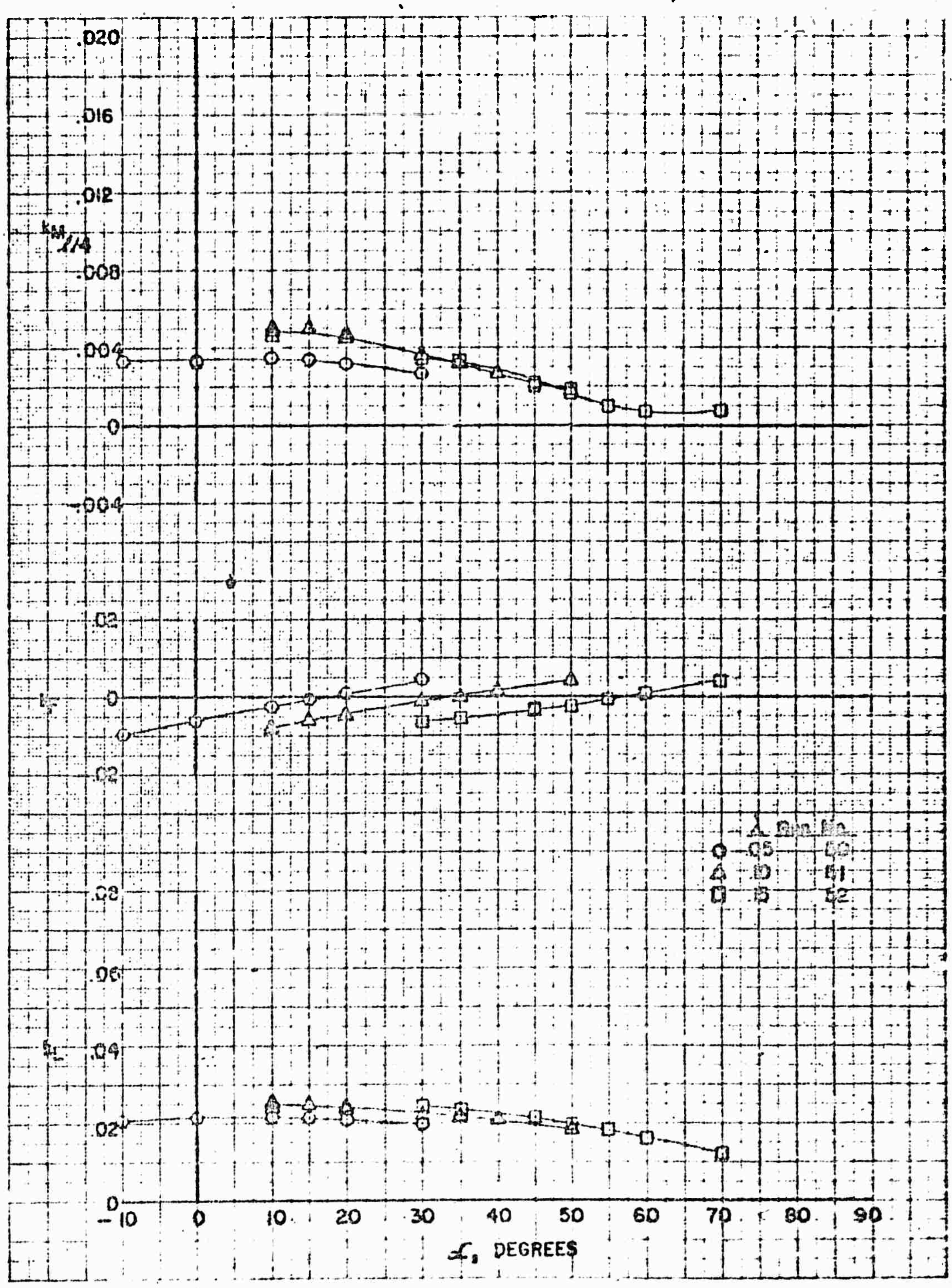


FIGURE 50a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_3S
$\beta = 15°$

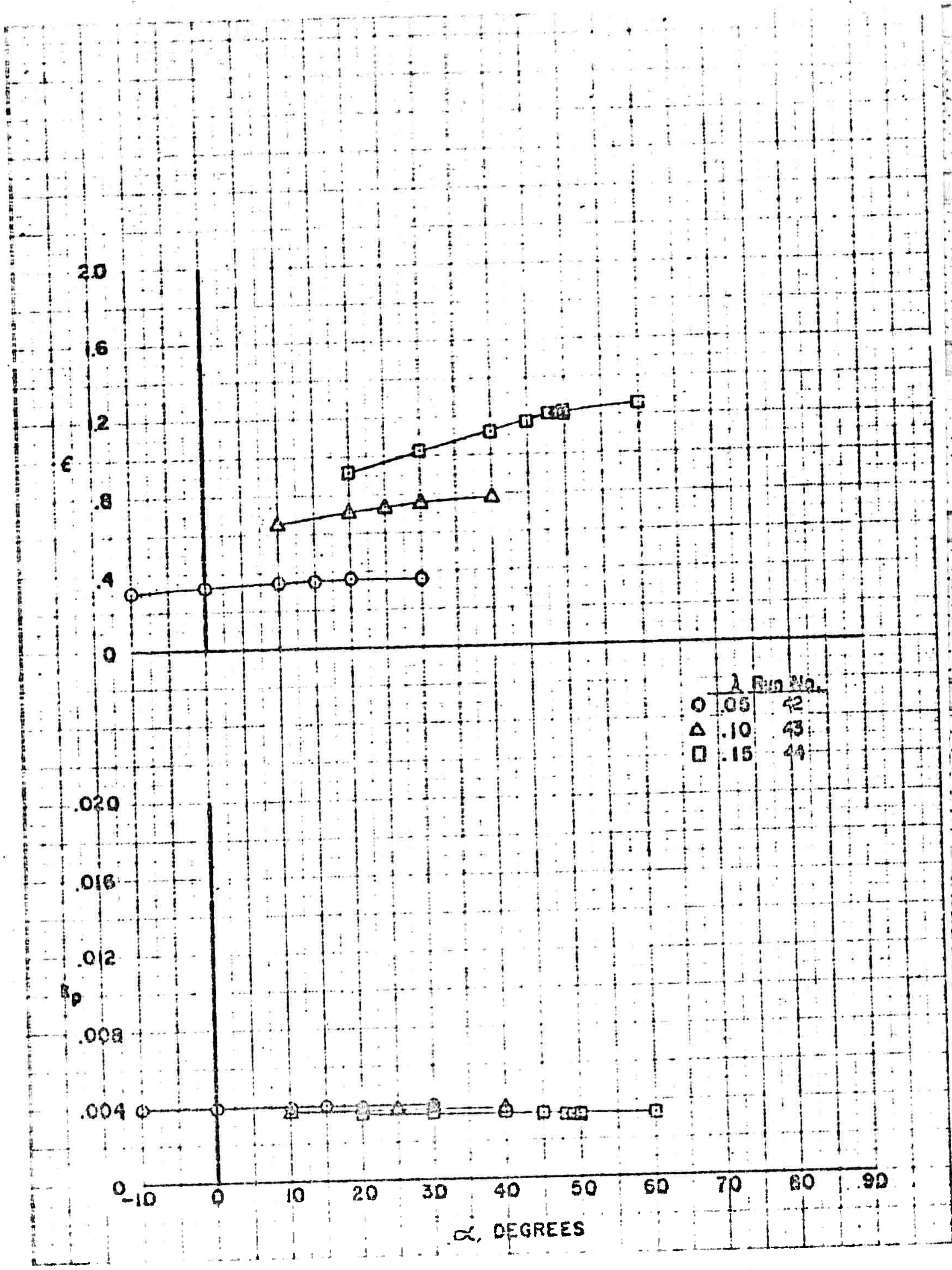


FIGURE 50b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_3S

$\beta = 15°$

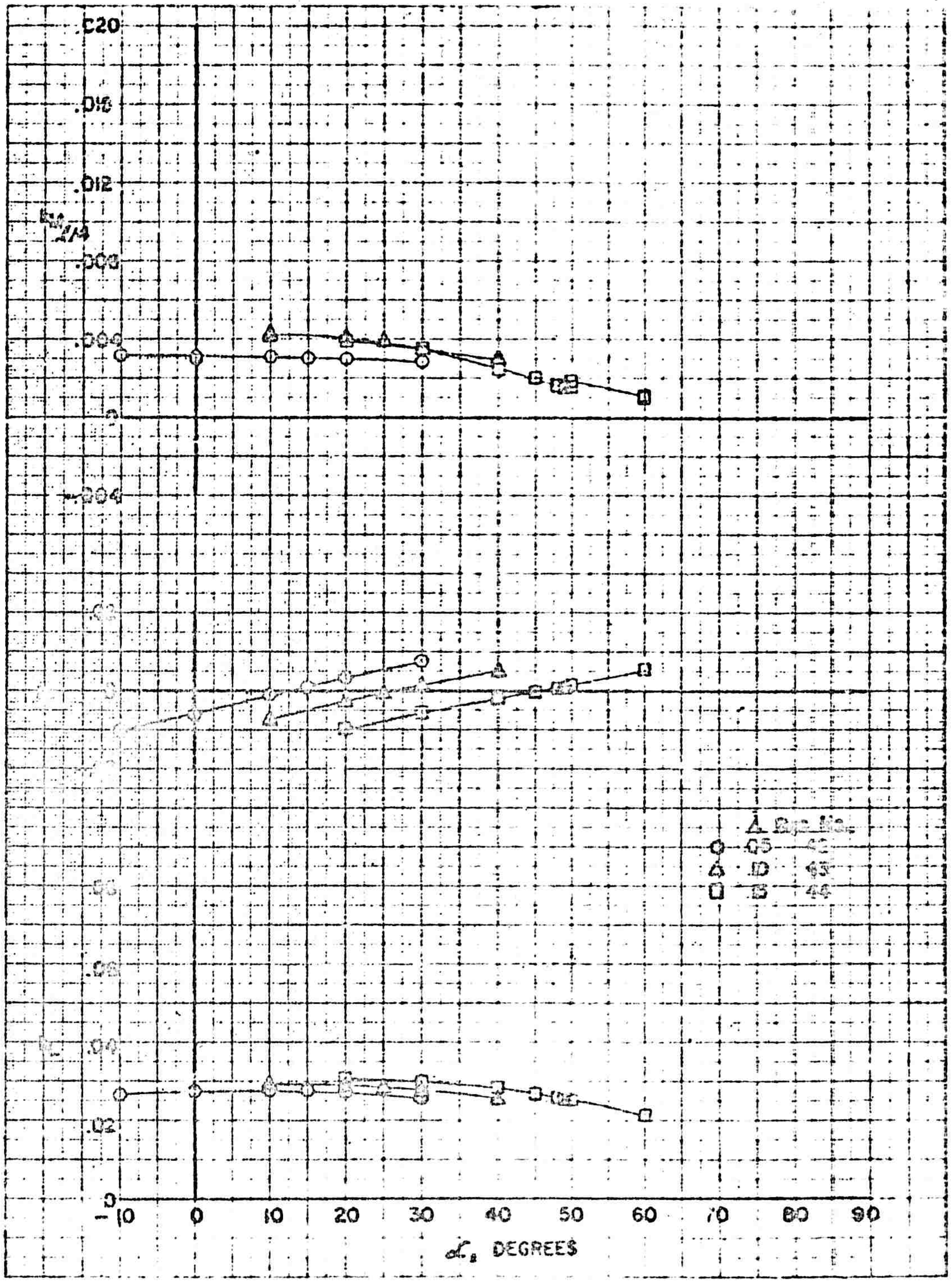


FIGURE 51a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_2P_3S

$\beta = 18°$

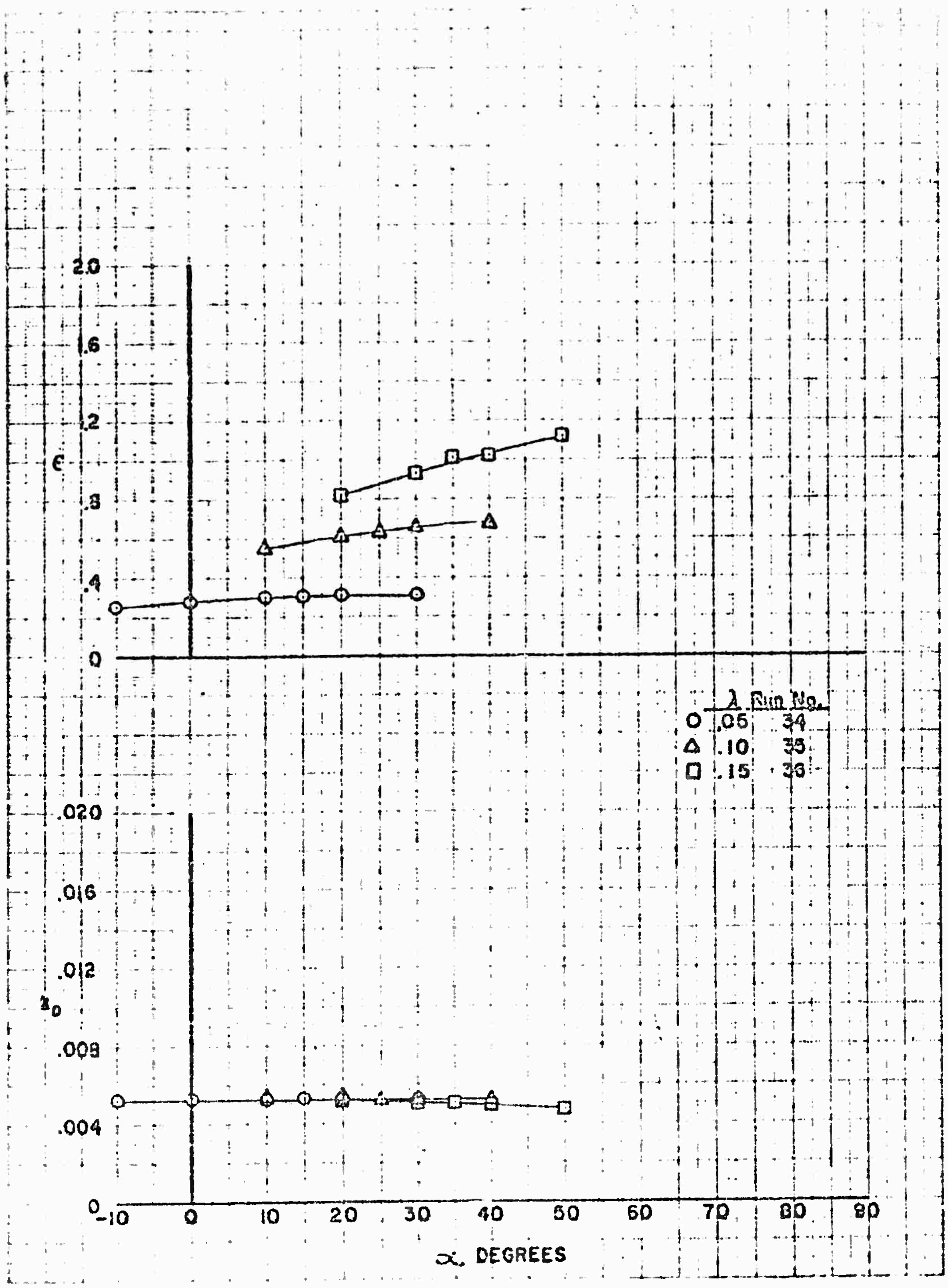


FIGURE 51b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_3S

$\beta = 18°$

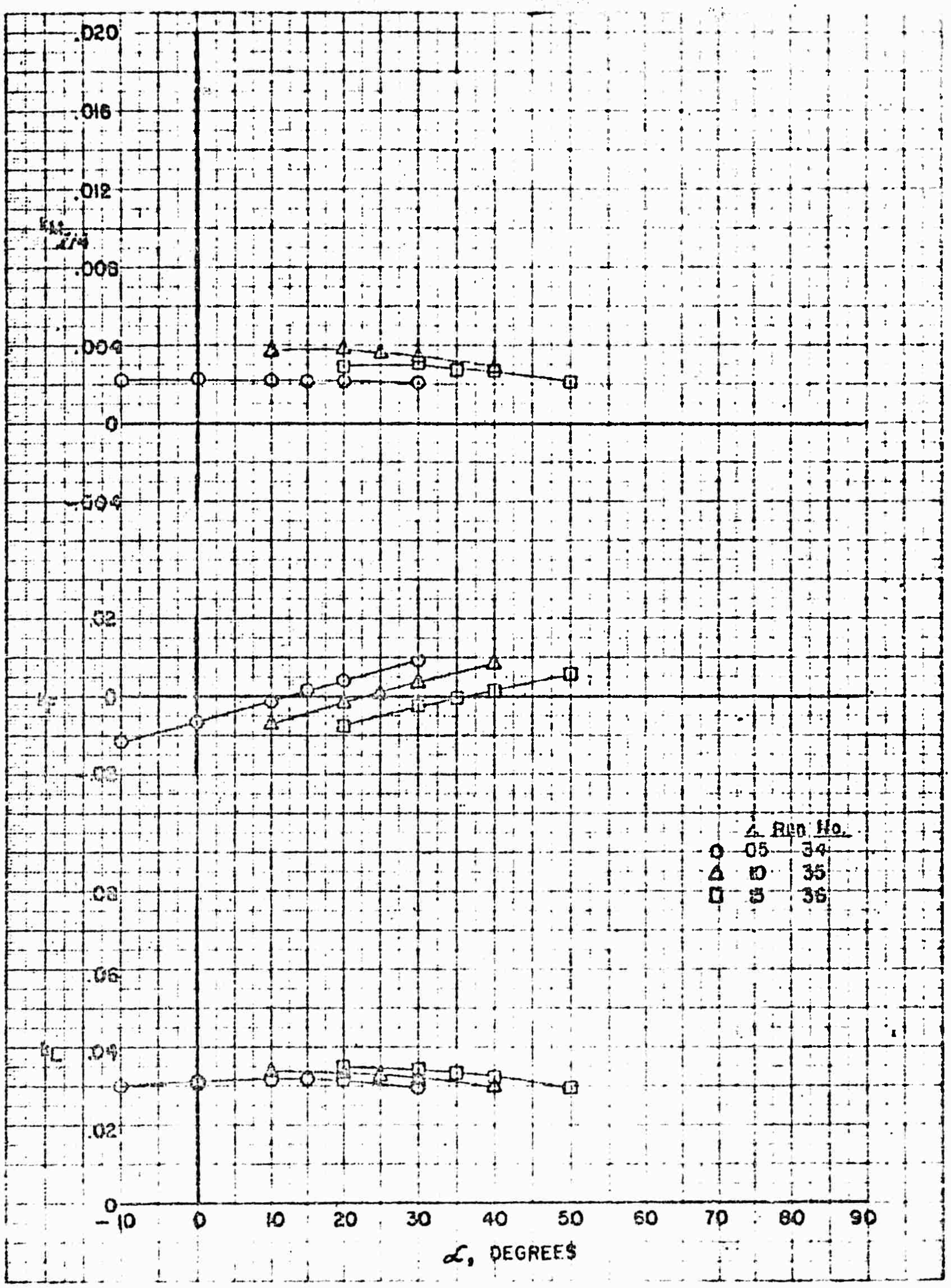


FIGURE 52a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

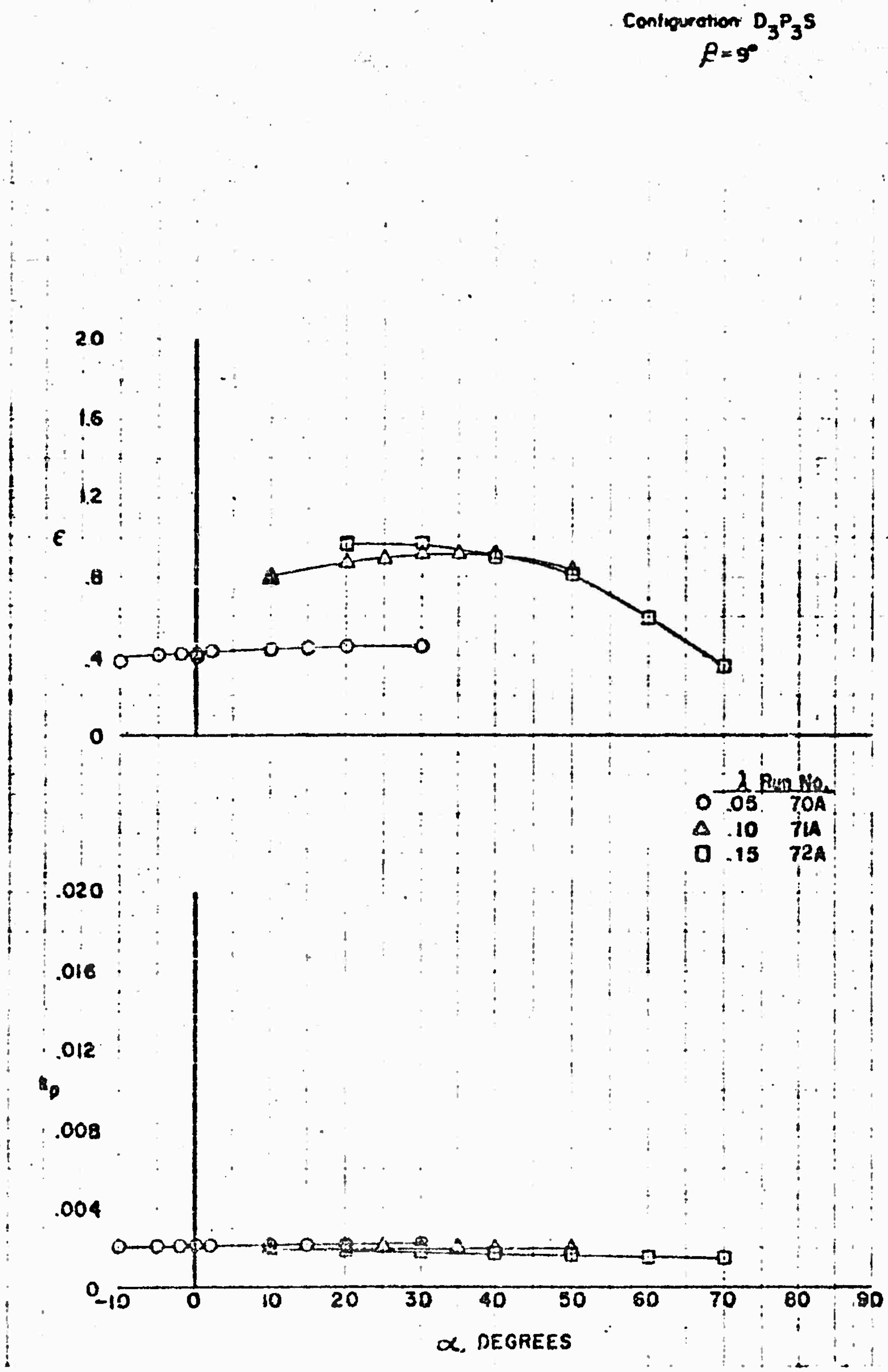


FIGURE 52b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

$\beta = 9^\circ$

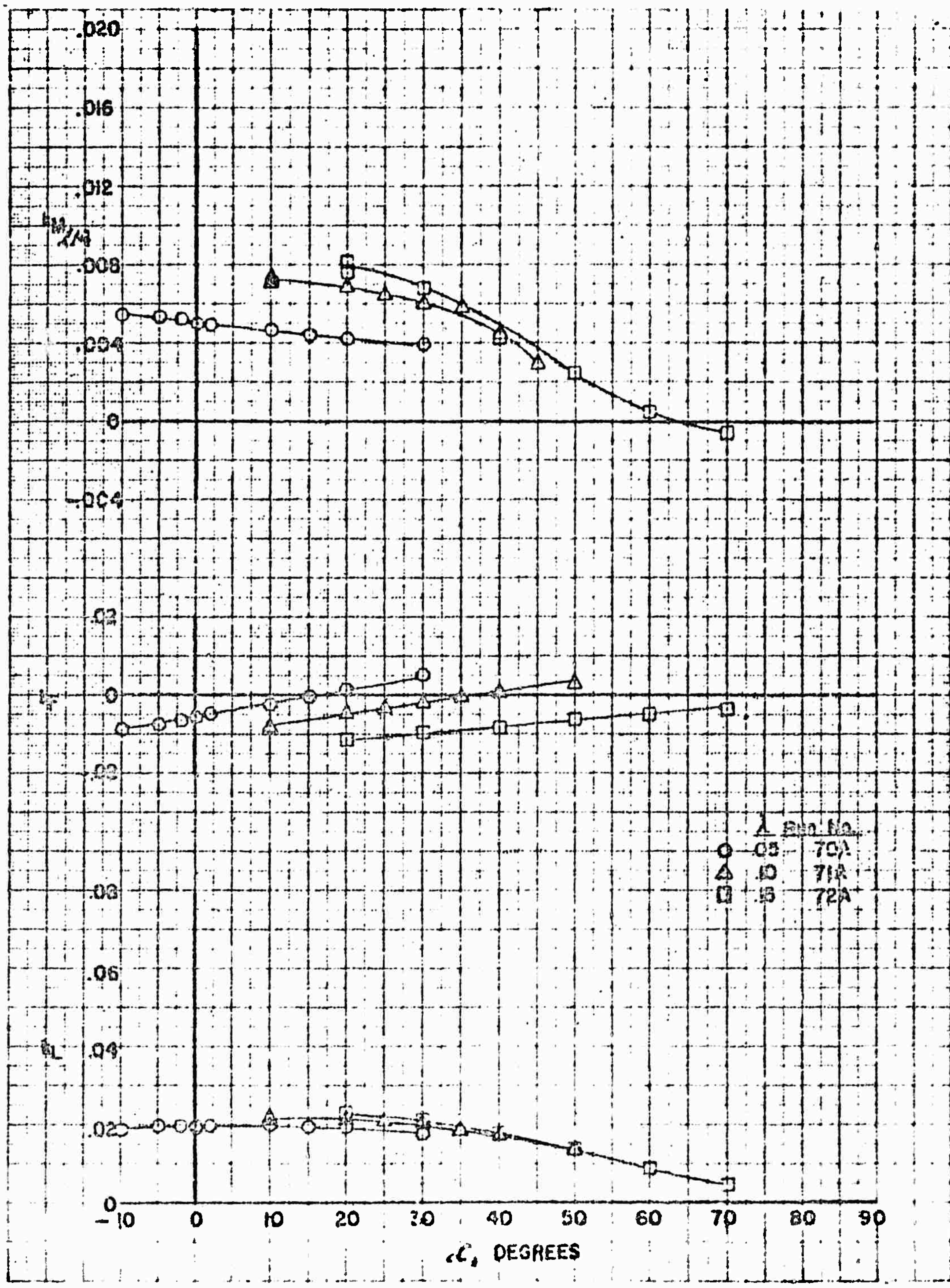


FIGURE 53a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S

$\beta = 12°$

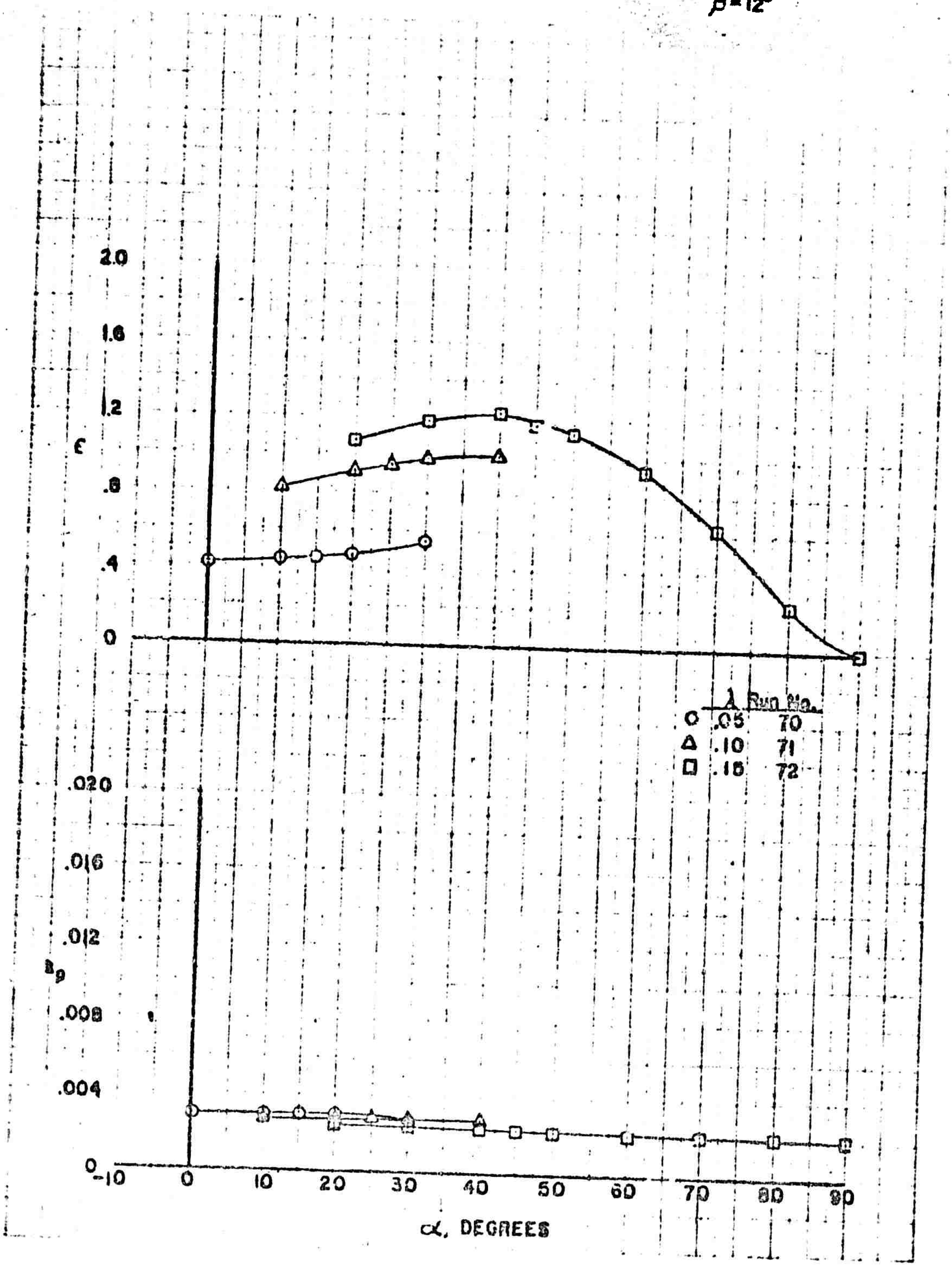


FIGURE 53b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

$\beta = 12°$

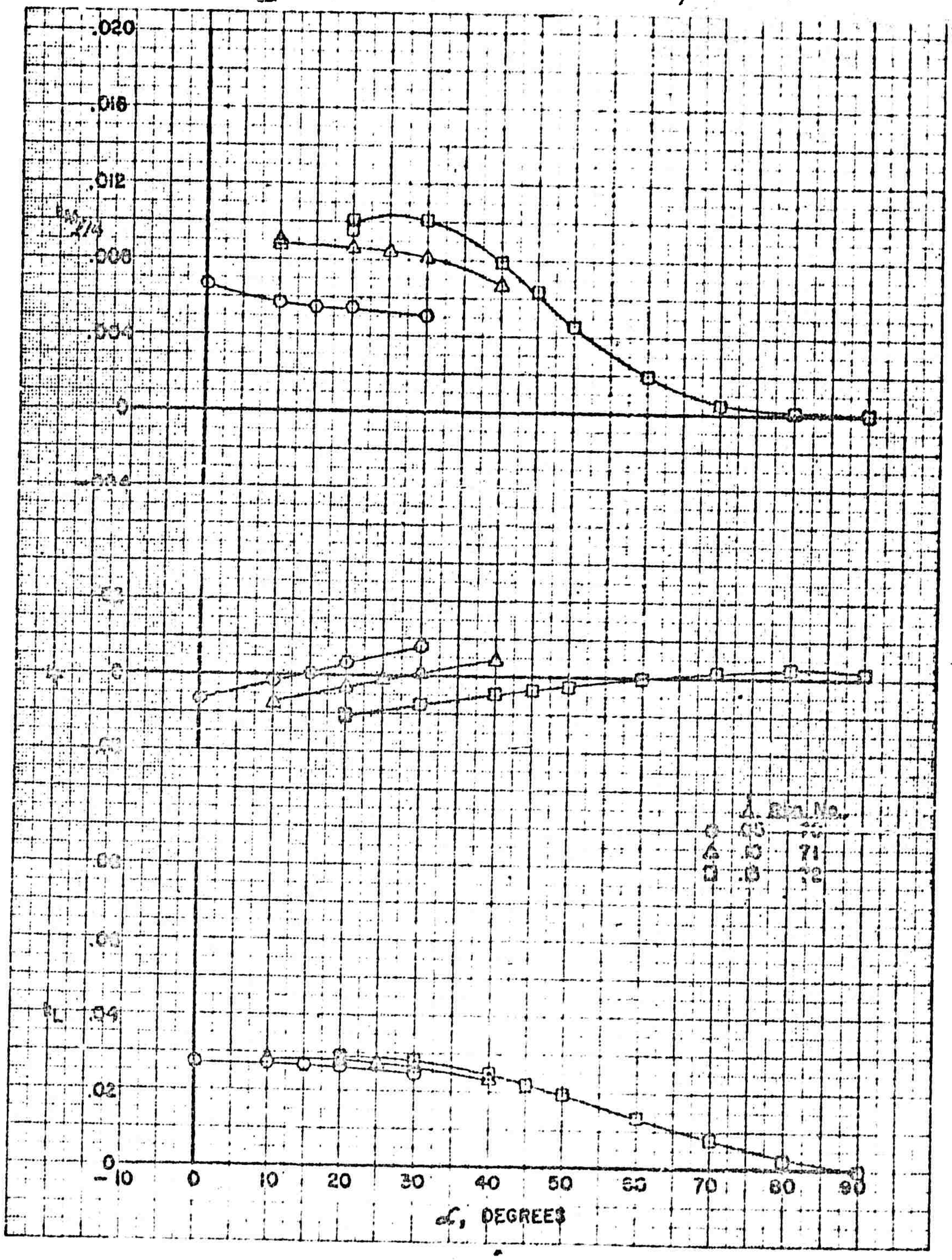


FIGURE 54a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (OO) Phase IV

Configuration D_3P_3S

$\beta = 15°$

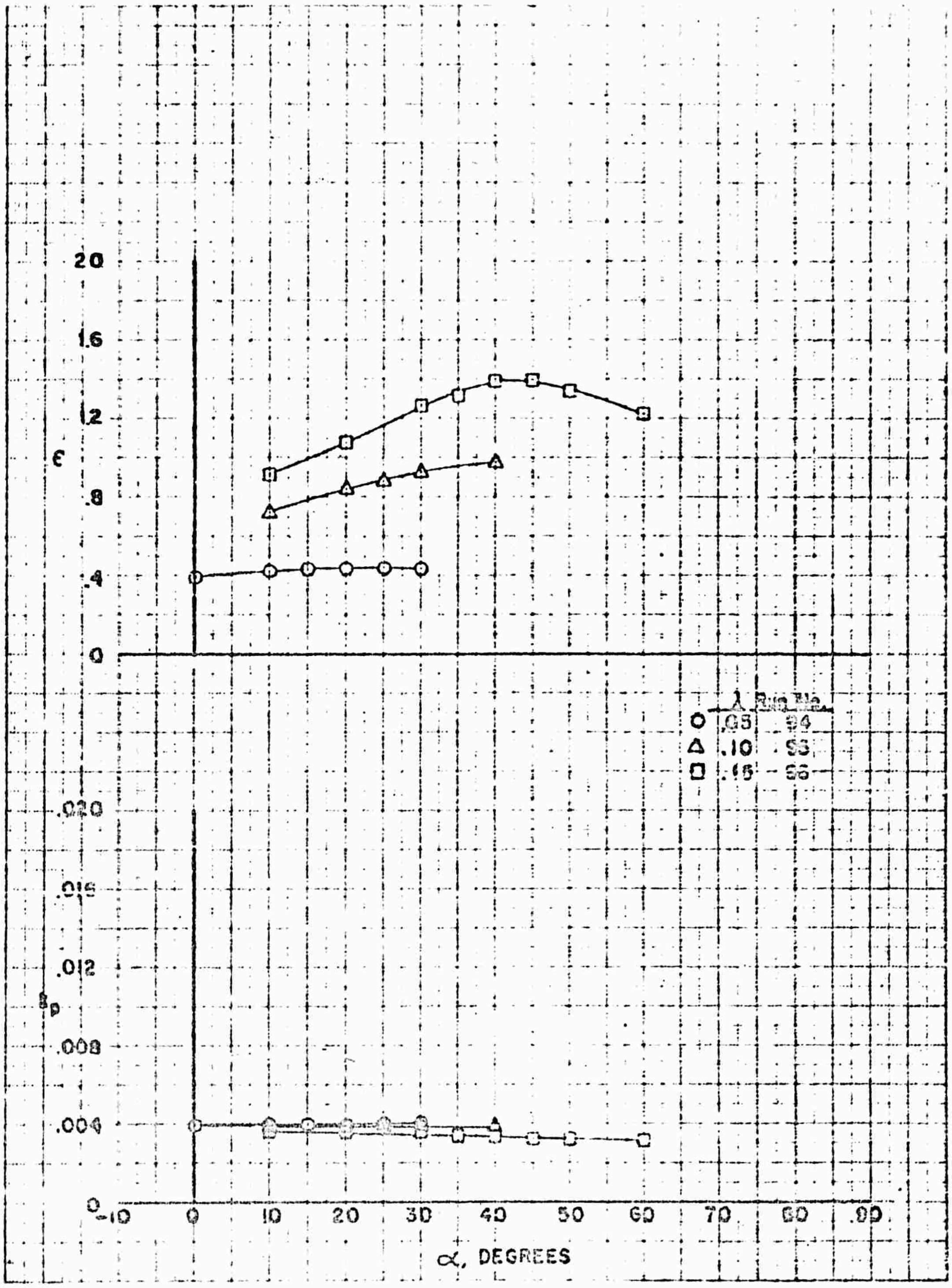


FIGURE 54b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S

$\beta = 15°$

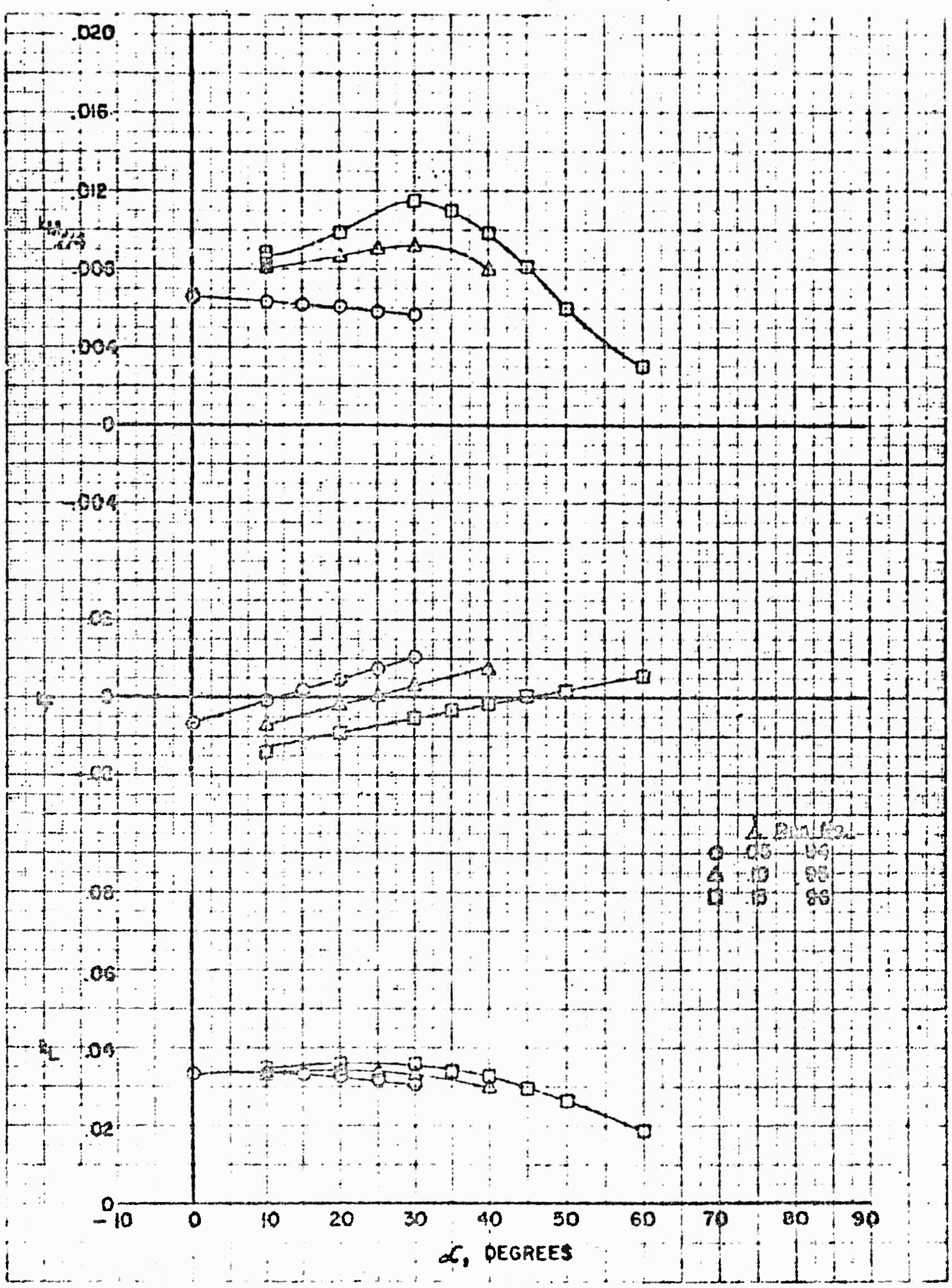


FIGURE 55a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

$\beta = 18°$

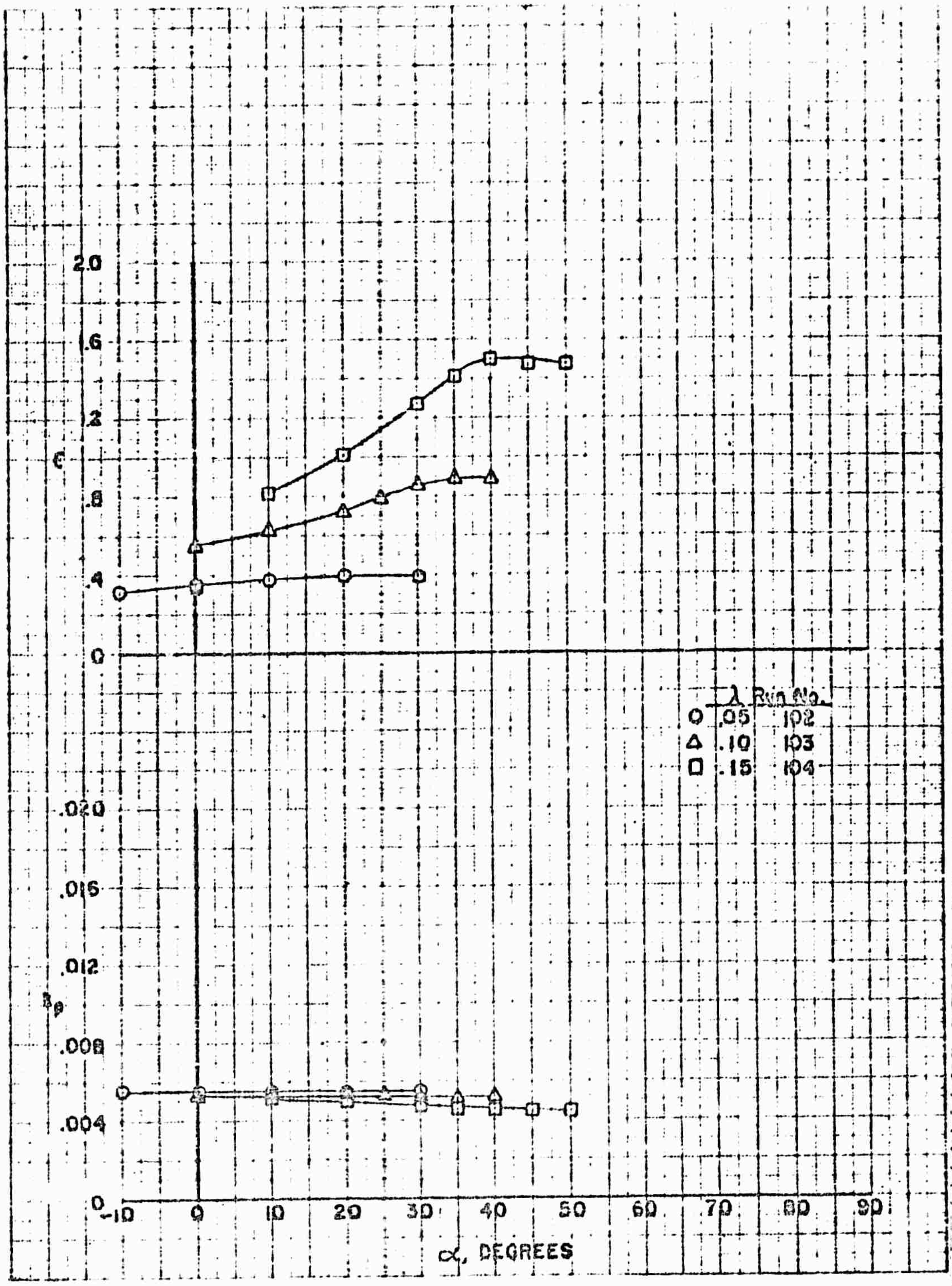


FIGURE 55b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S
$\beta = 18°$

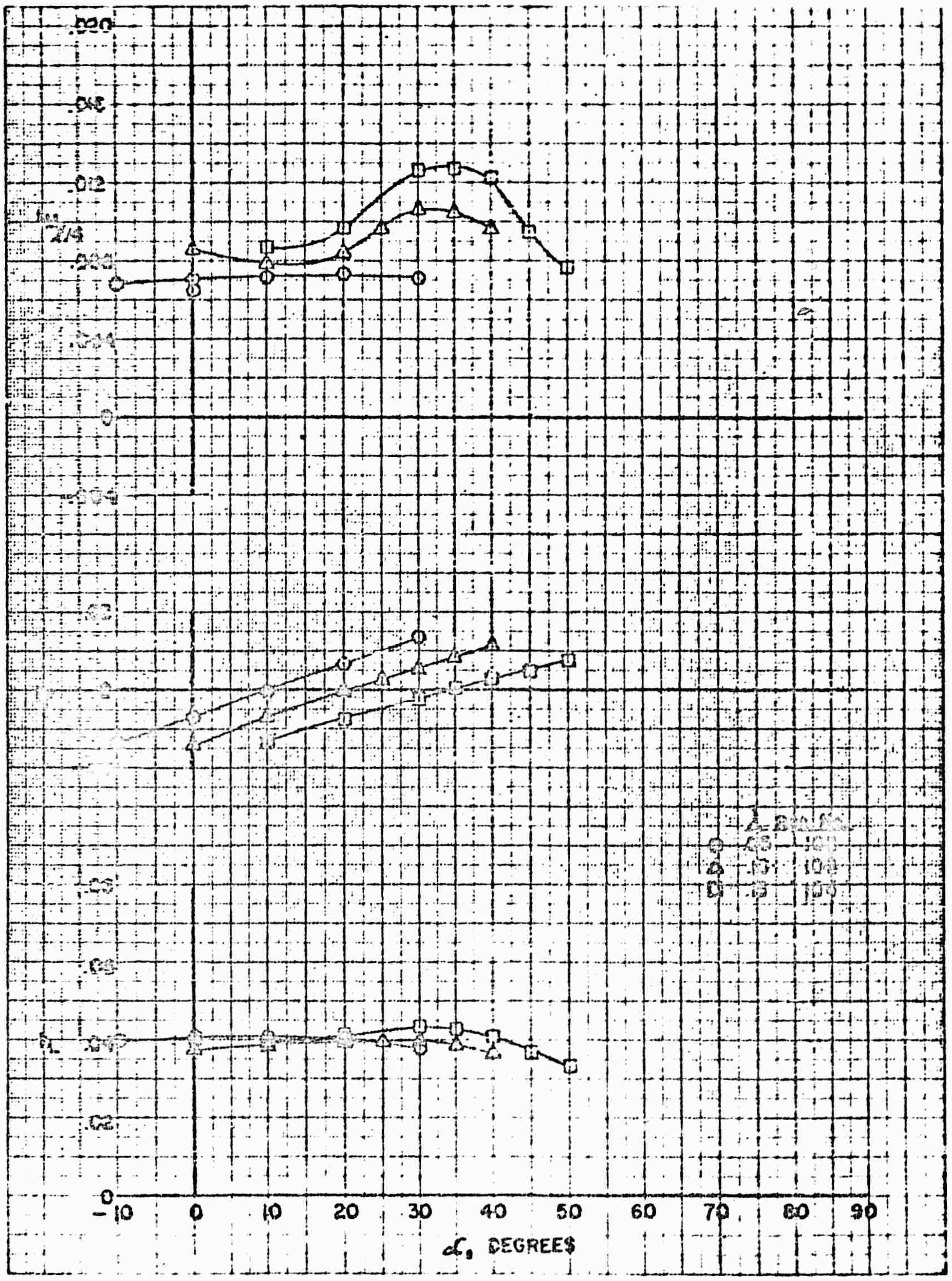


FIGURE 56a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (OD) Phase IV

Configuration: D_3P_3S

$\beta = 21°$

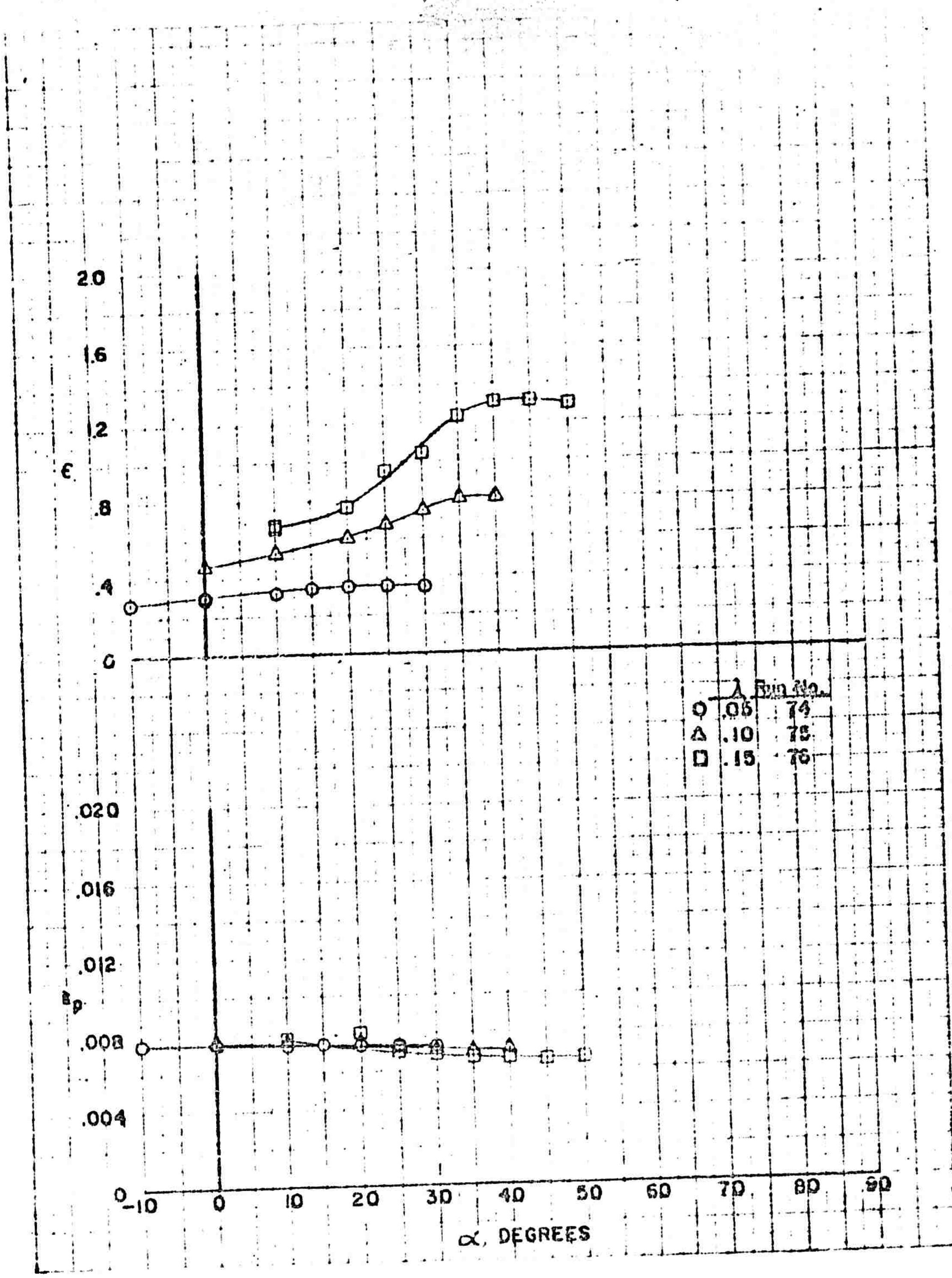


FIGURE 56b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S
$\beta = 21°$

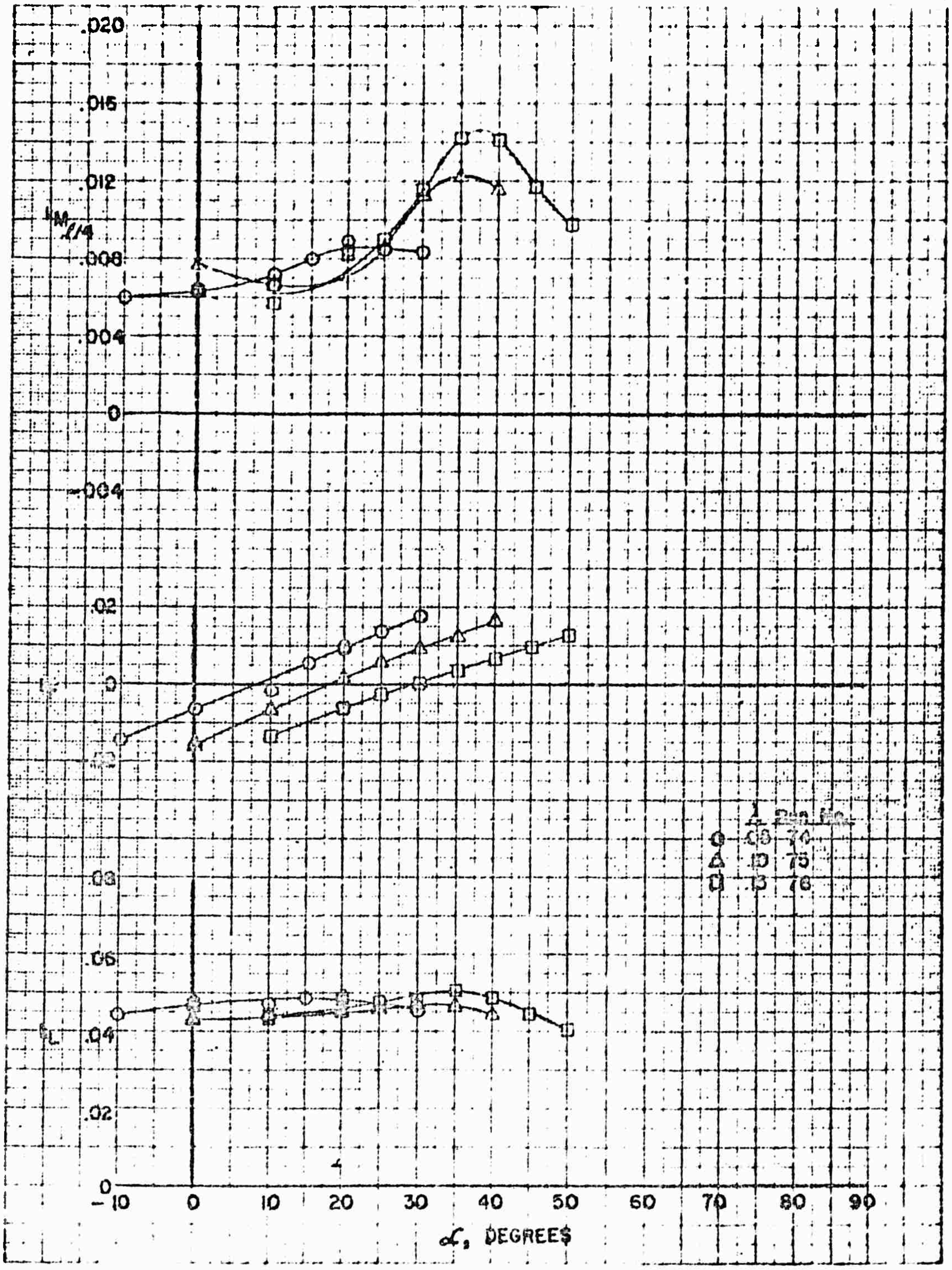


FIGURE 57a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S
$\beta = 24°$

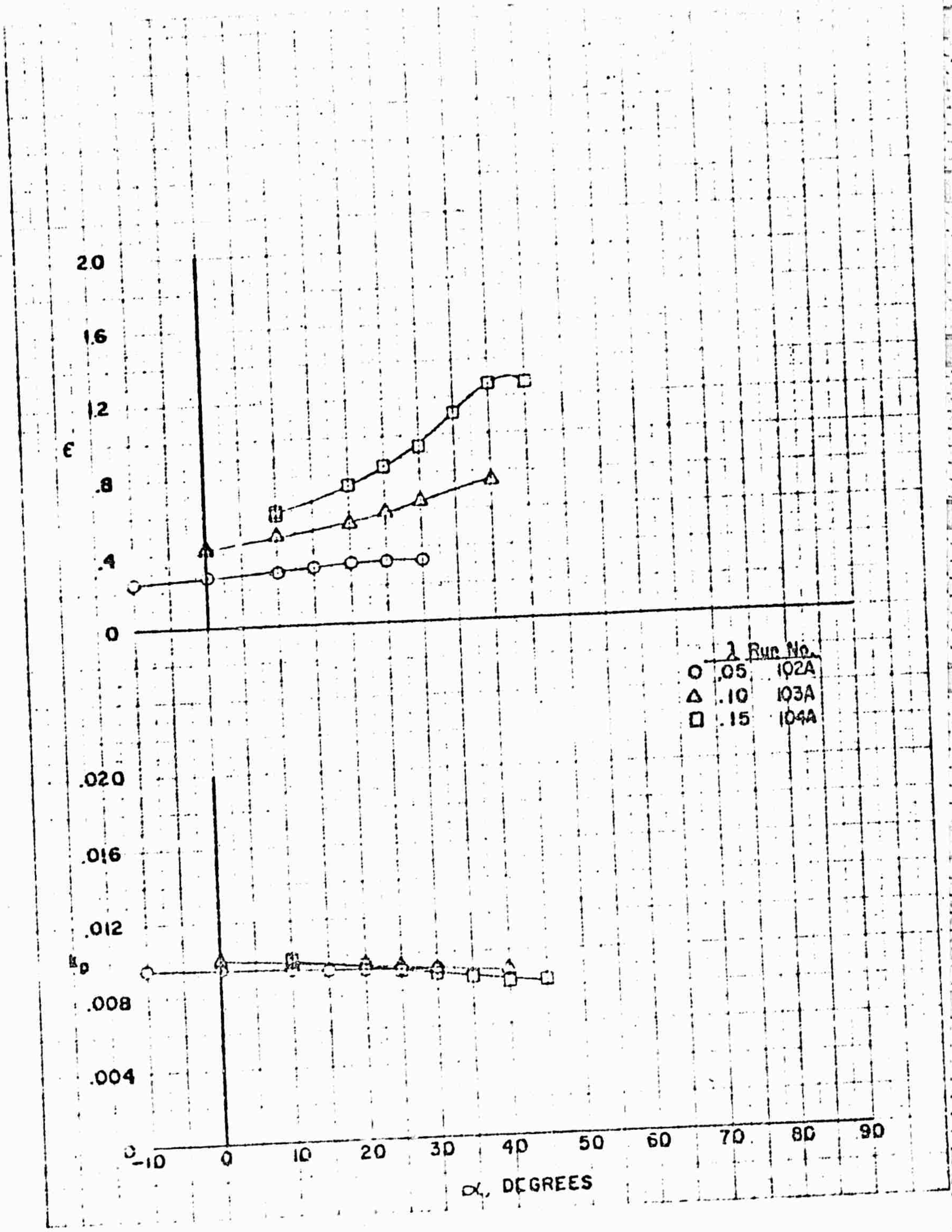


FIGURE 57b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S

$\beta = 24°$

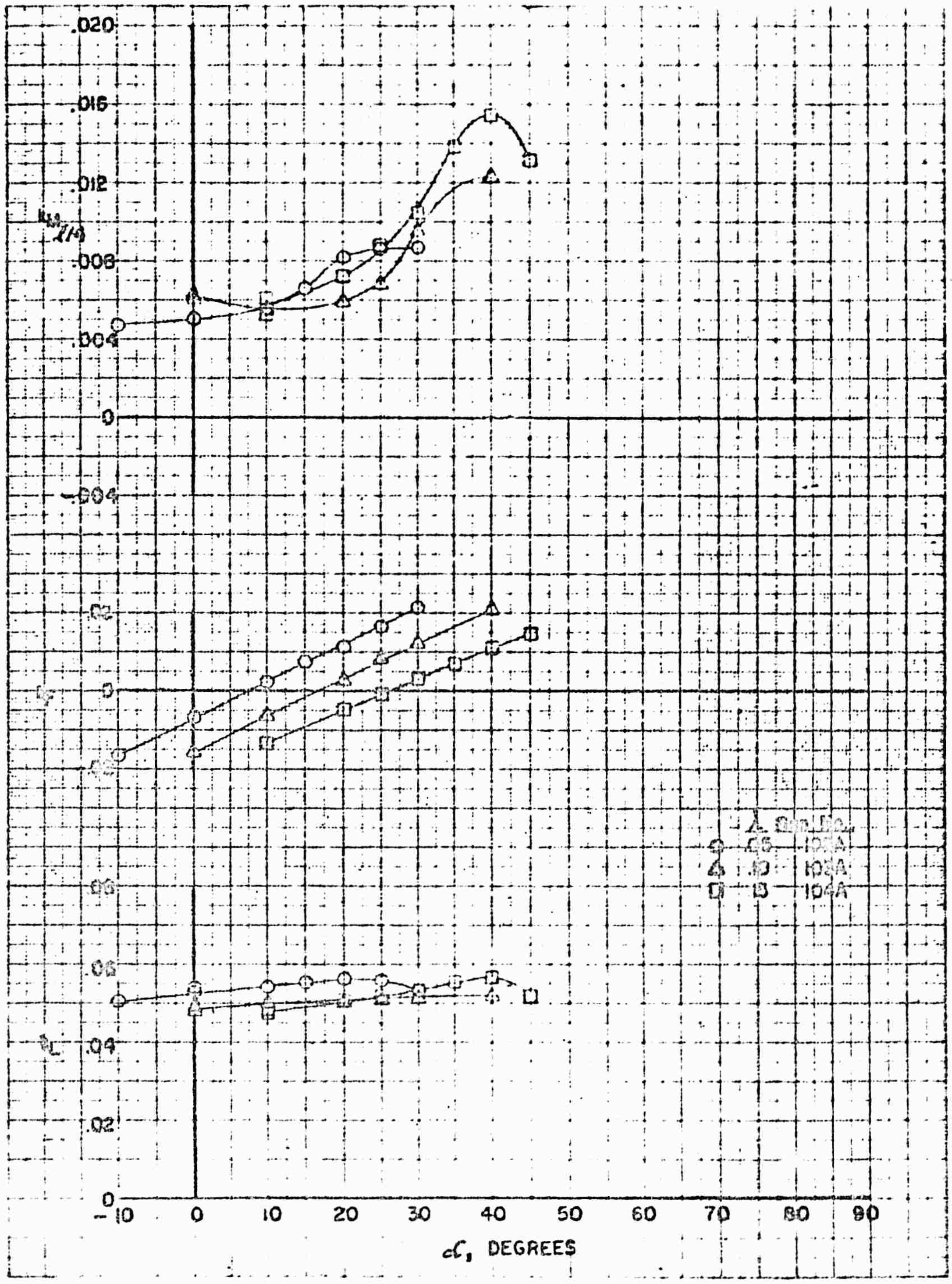


FIGURE 58a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\beta = 9°$

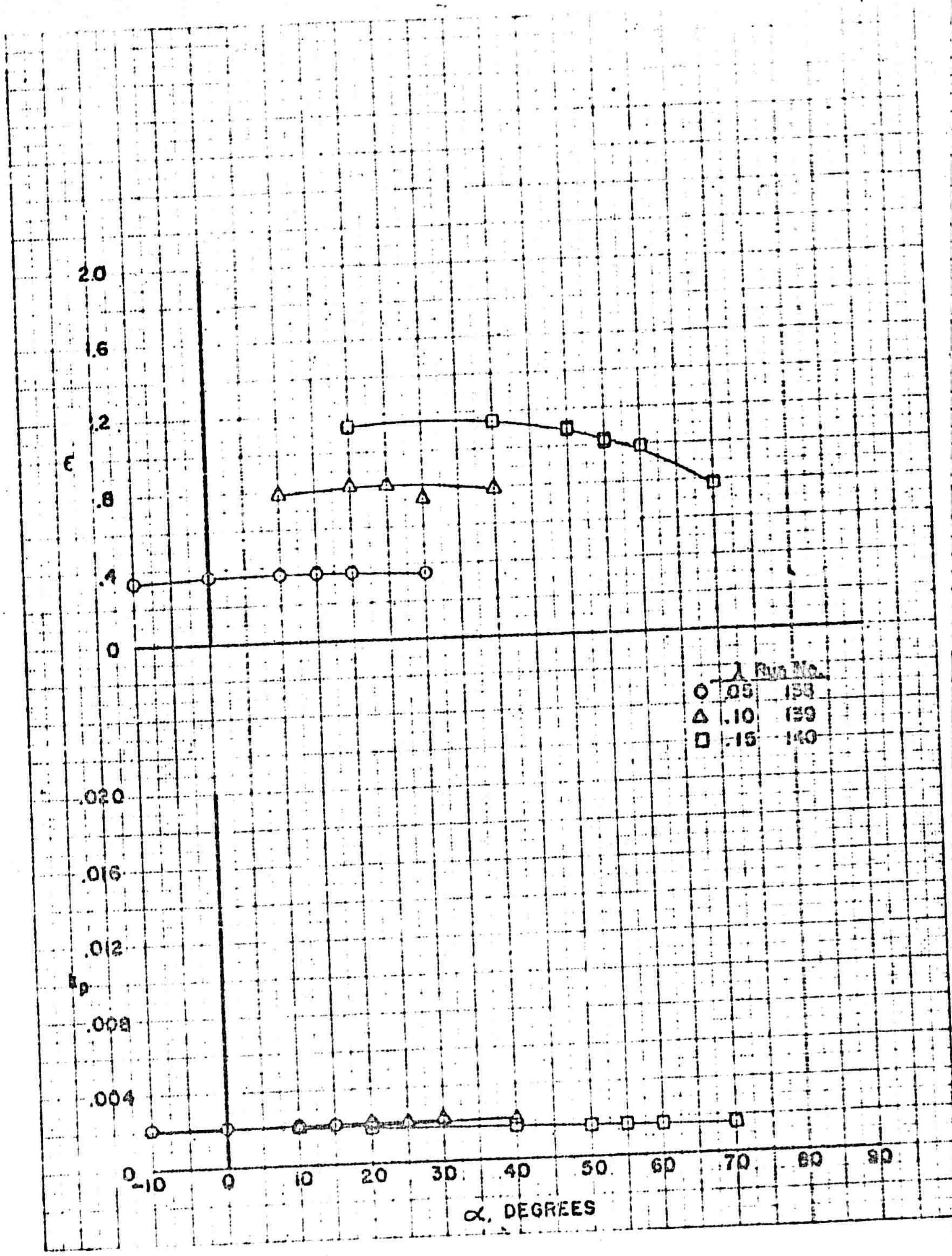


FIGURE 58b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

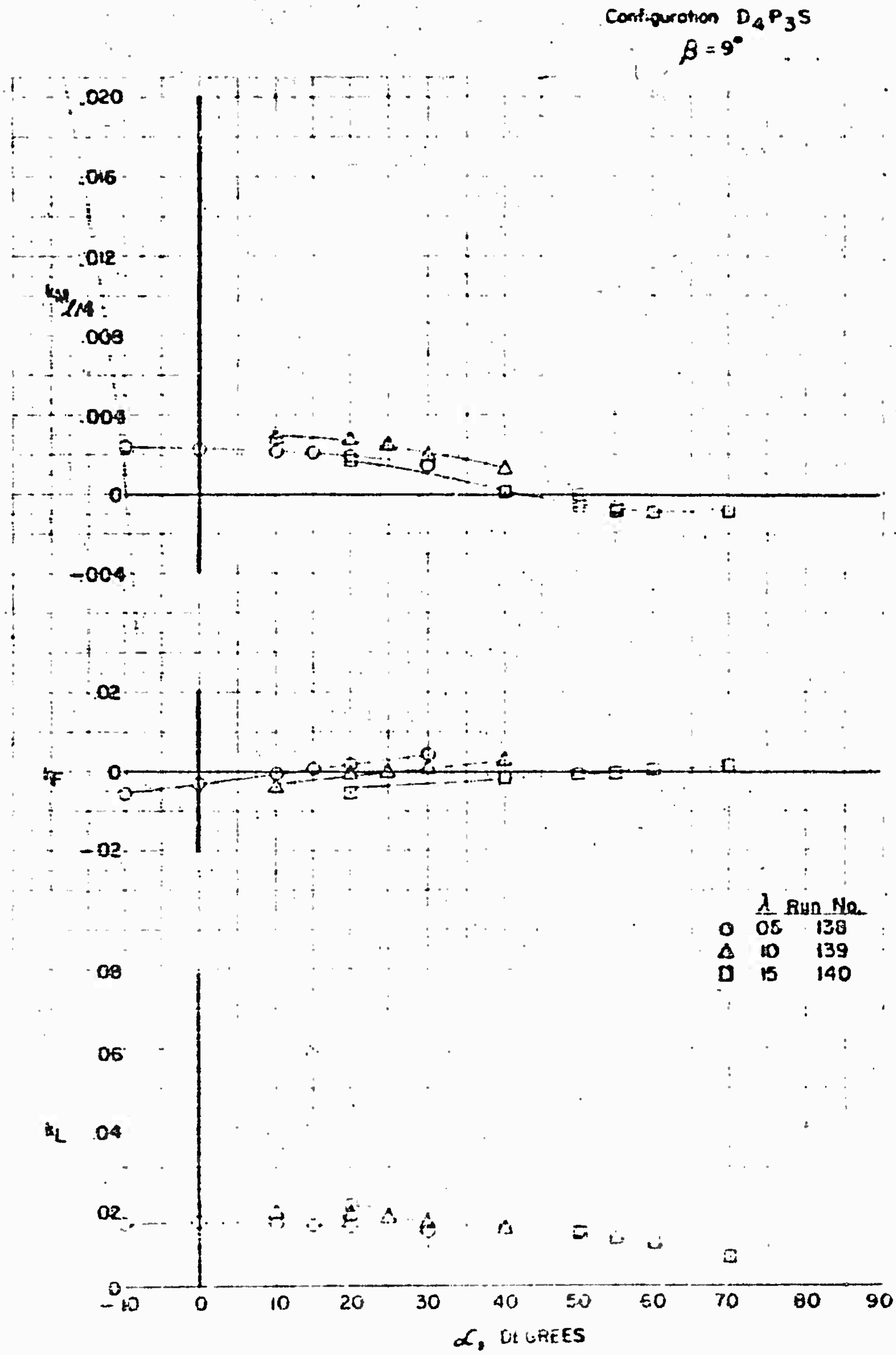


FIGURE 59a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\beta = 12°$

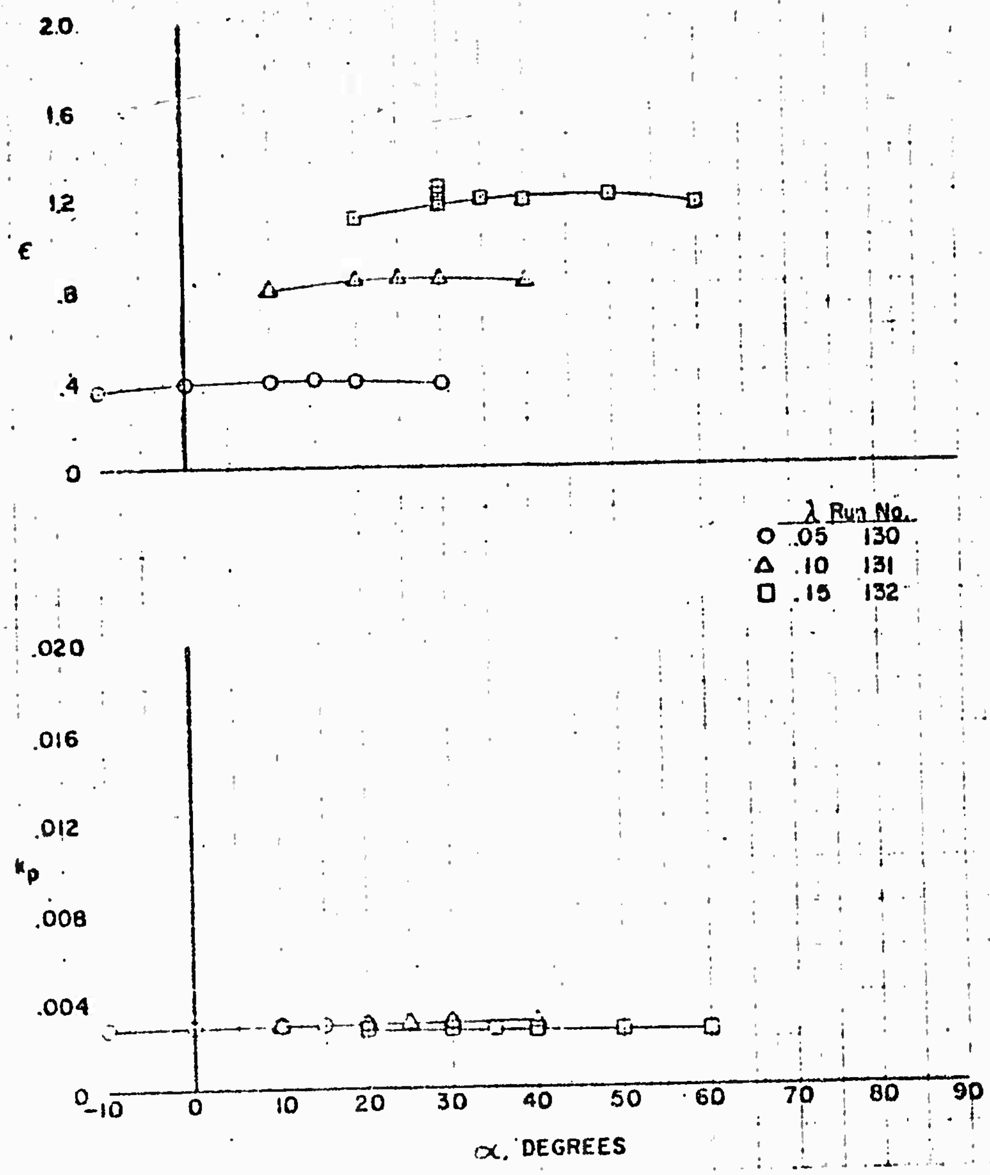


FIGURE 59b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\beta = 12°$

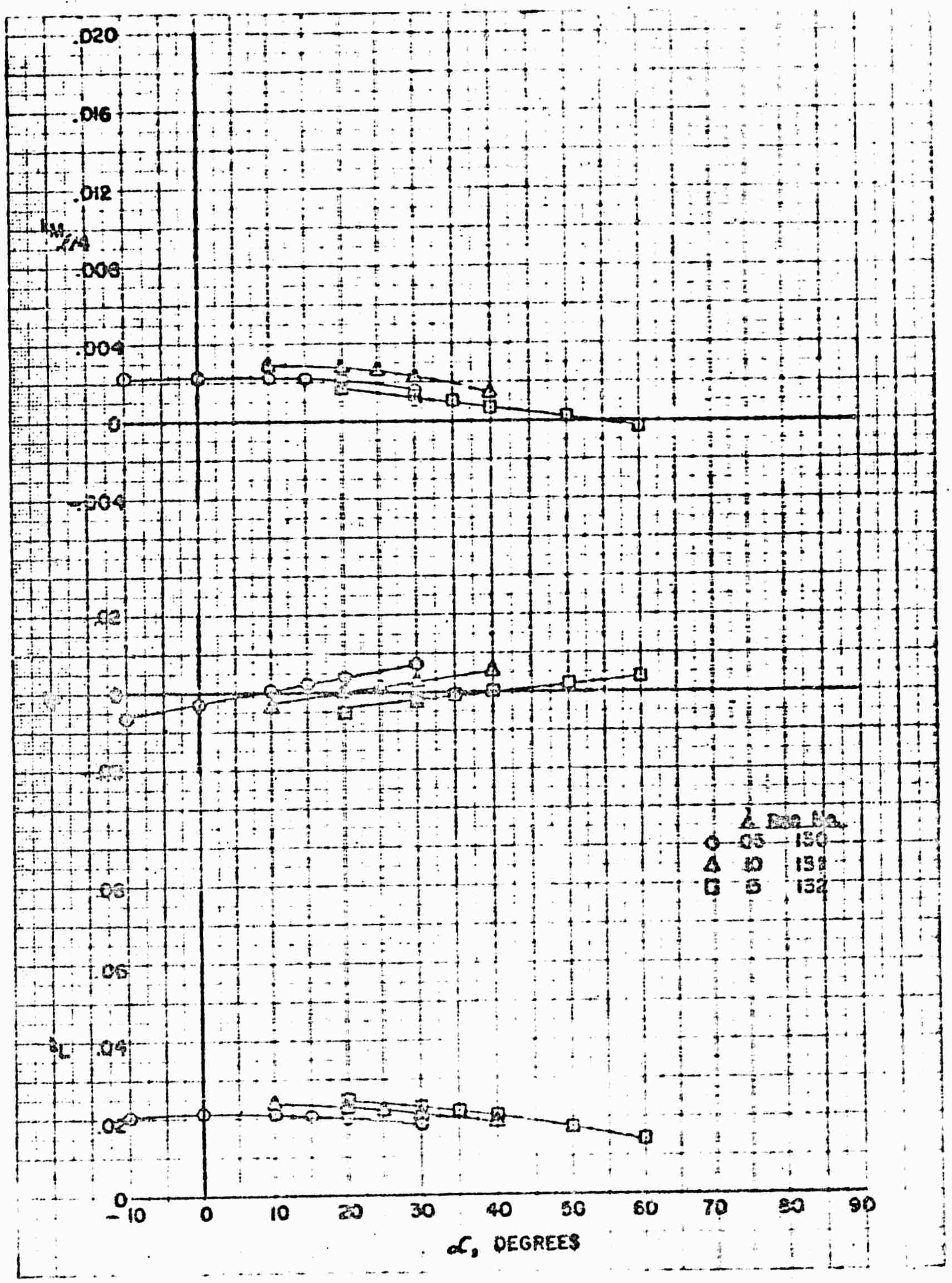


FIGURE 60a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\beta = 15°$

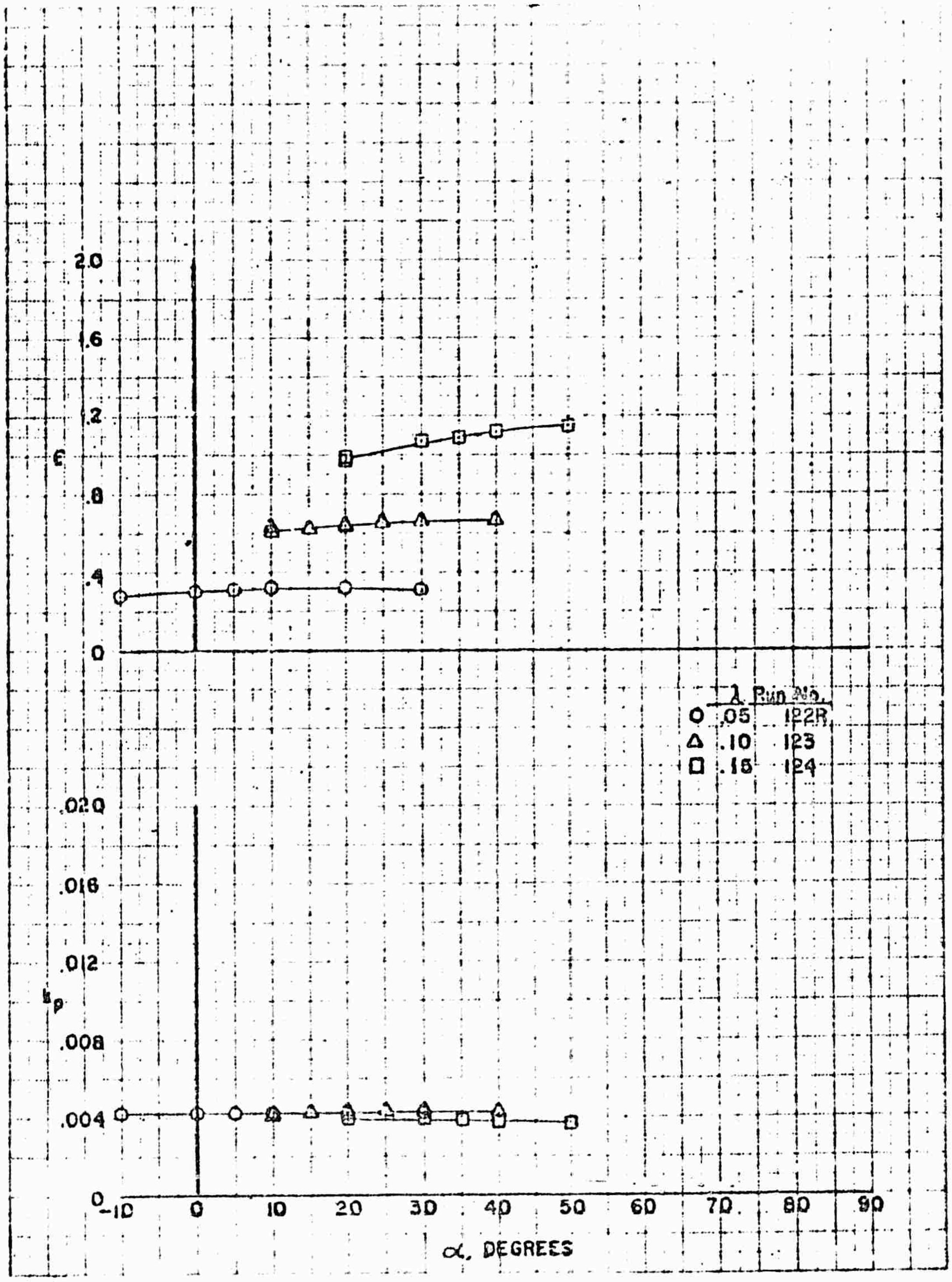


FIGURE 60b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\beta = 15°$

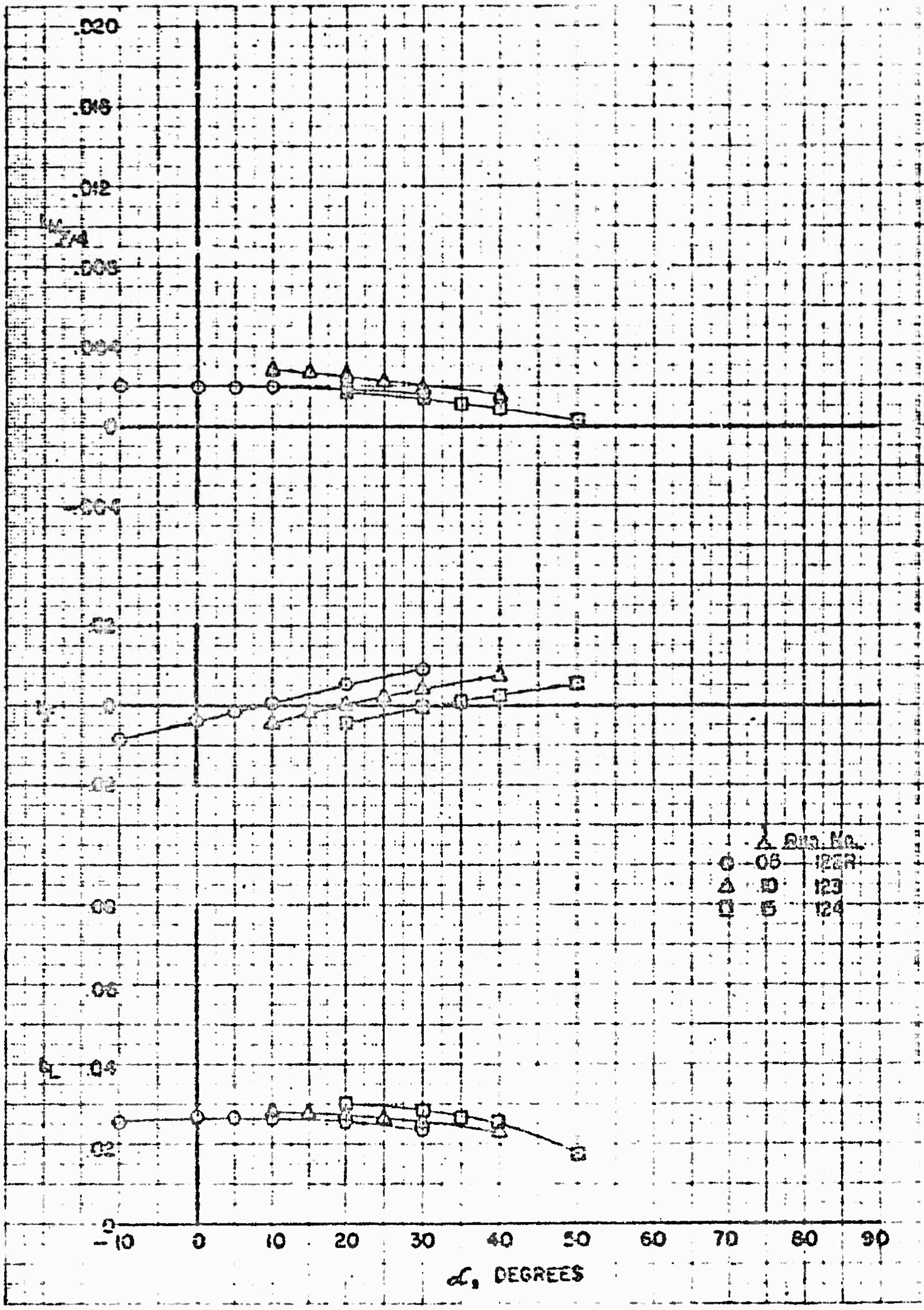


FIGURE 61a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\beta = 18°$

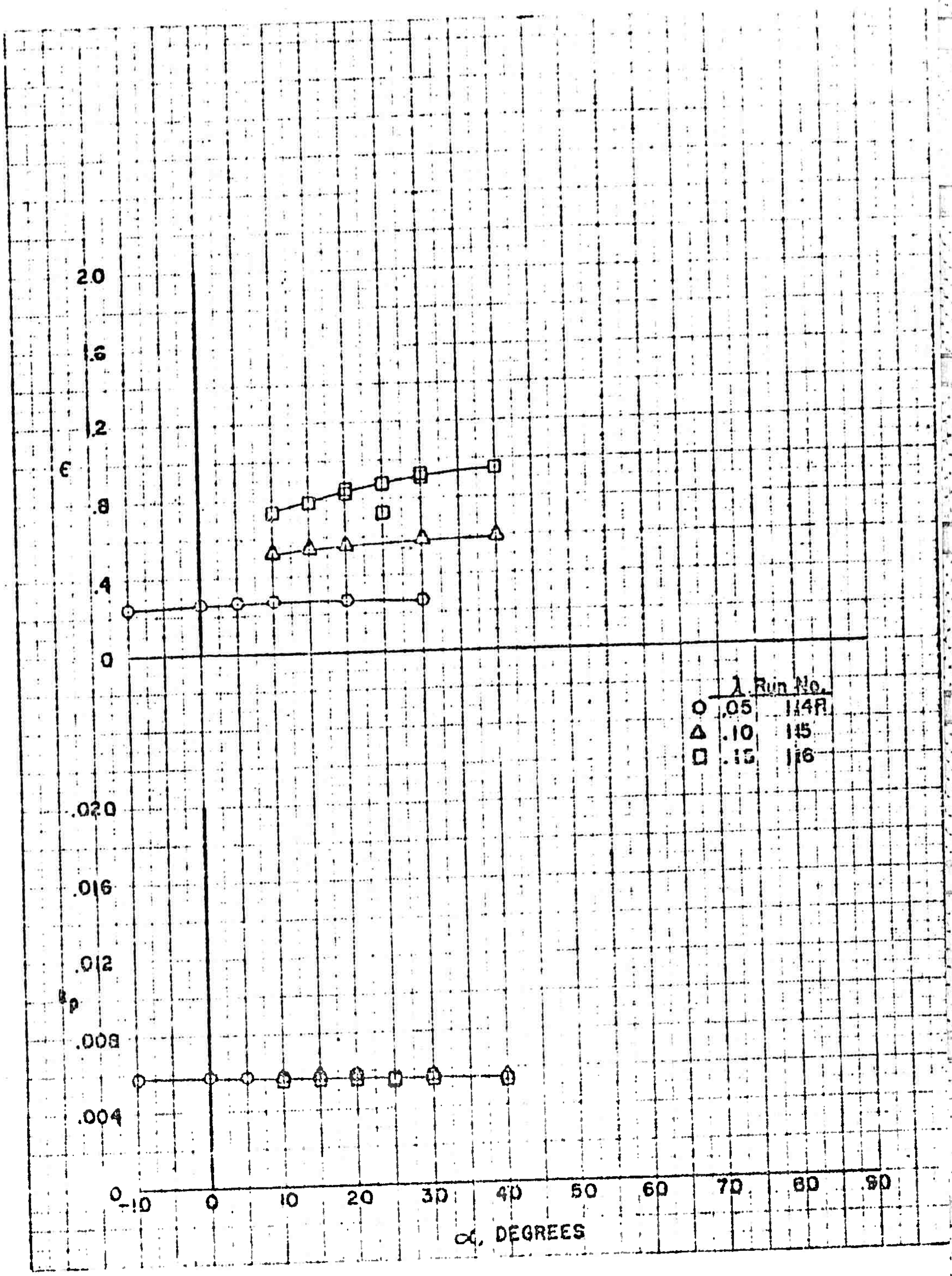


FIGURE 61b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\beta = 18°$

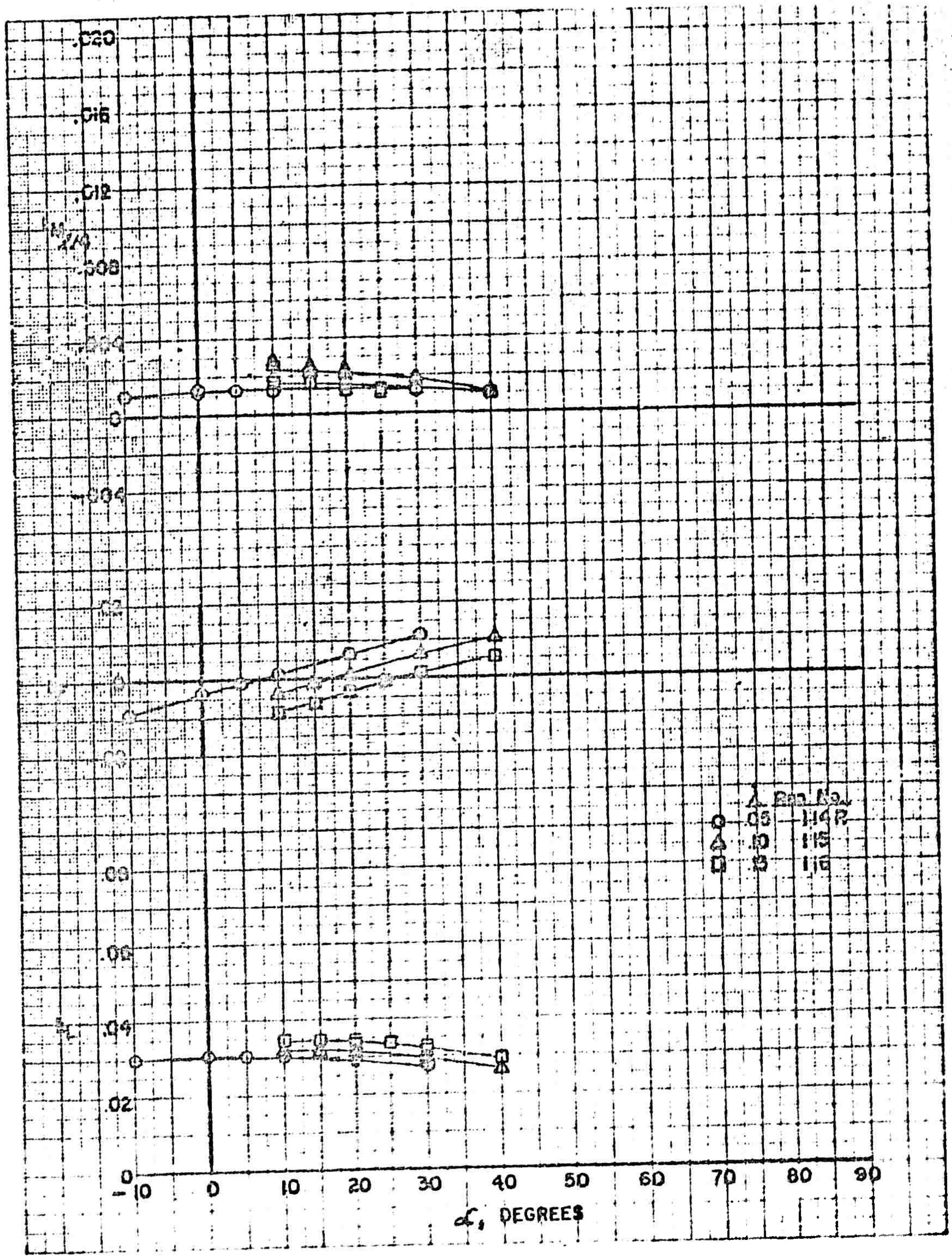


FIGURE 62a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_1P_2S

$\beta = 12°$

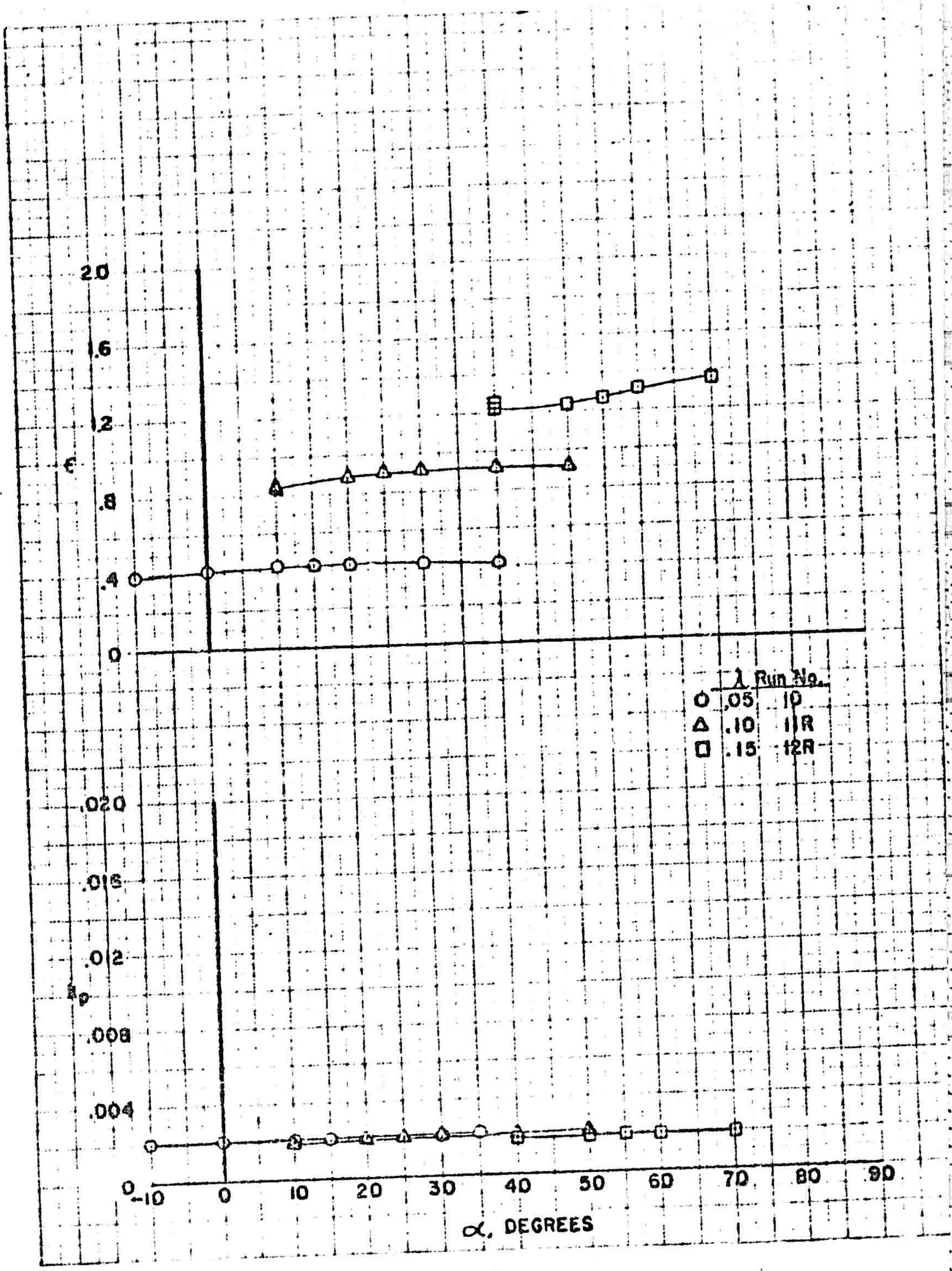


FIGURE 62b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr. 1357 (00) Phase IV

Configuration: D_1P_2S

$\beta = 12°$

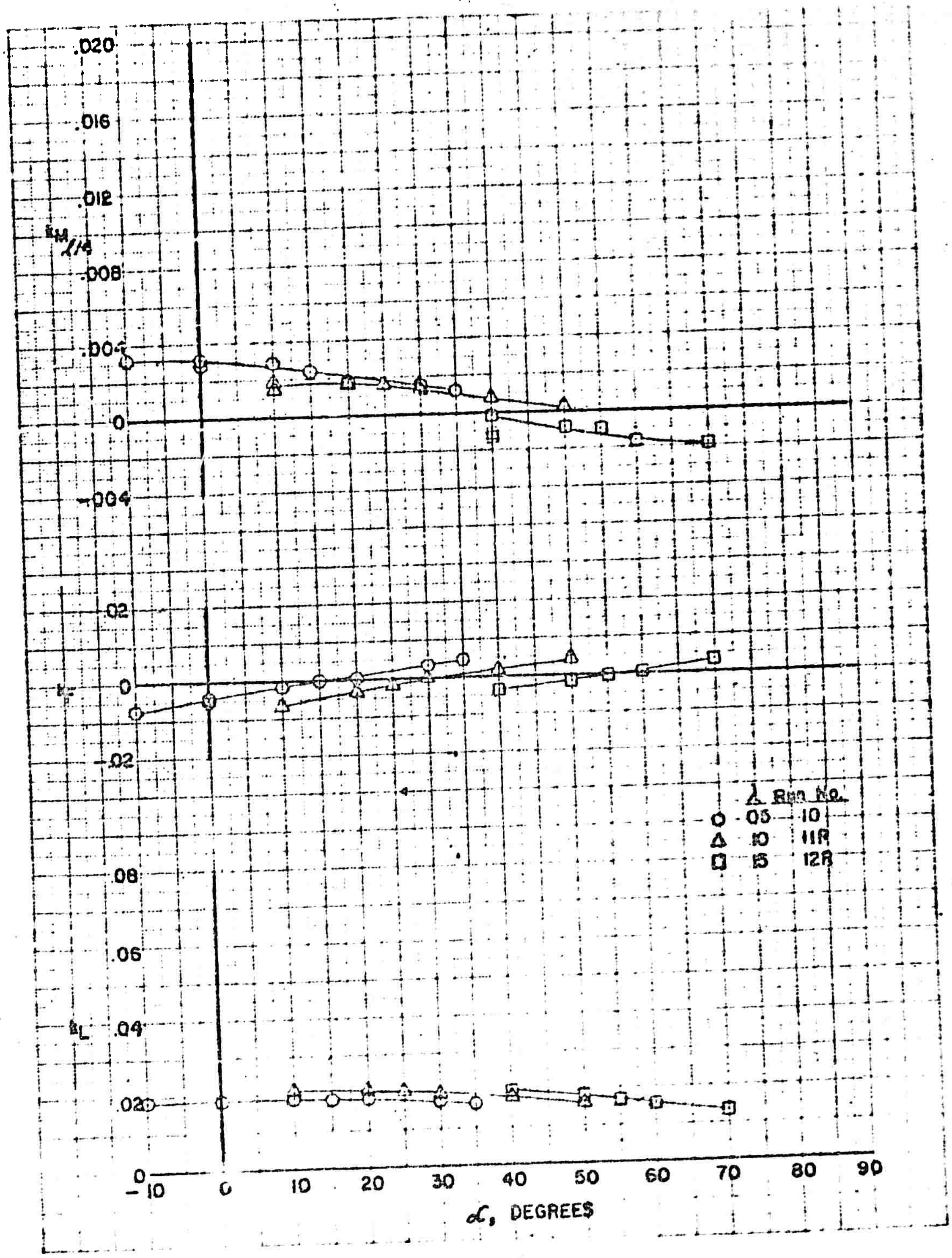


FIGURE 63a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_2S

$\beta = 12°$

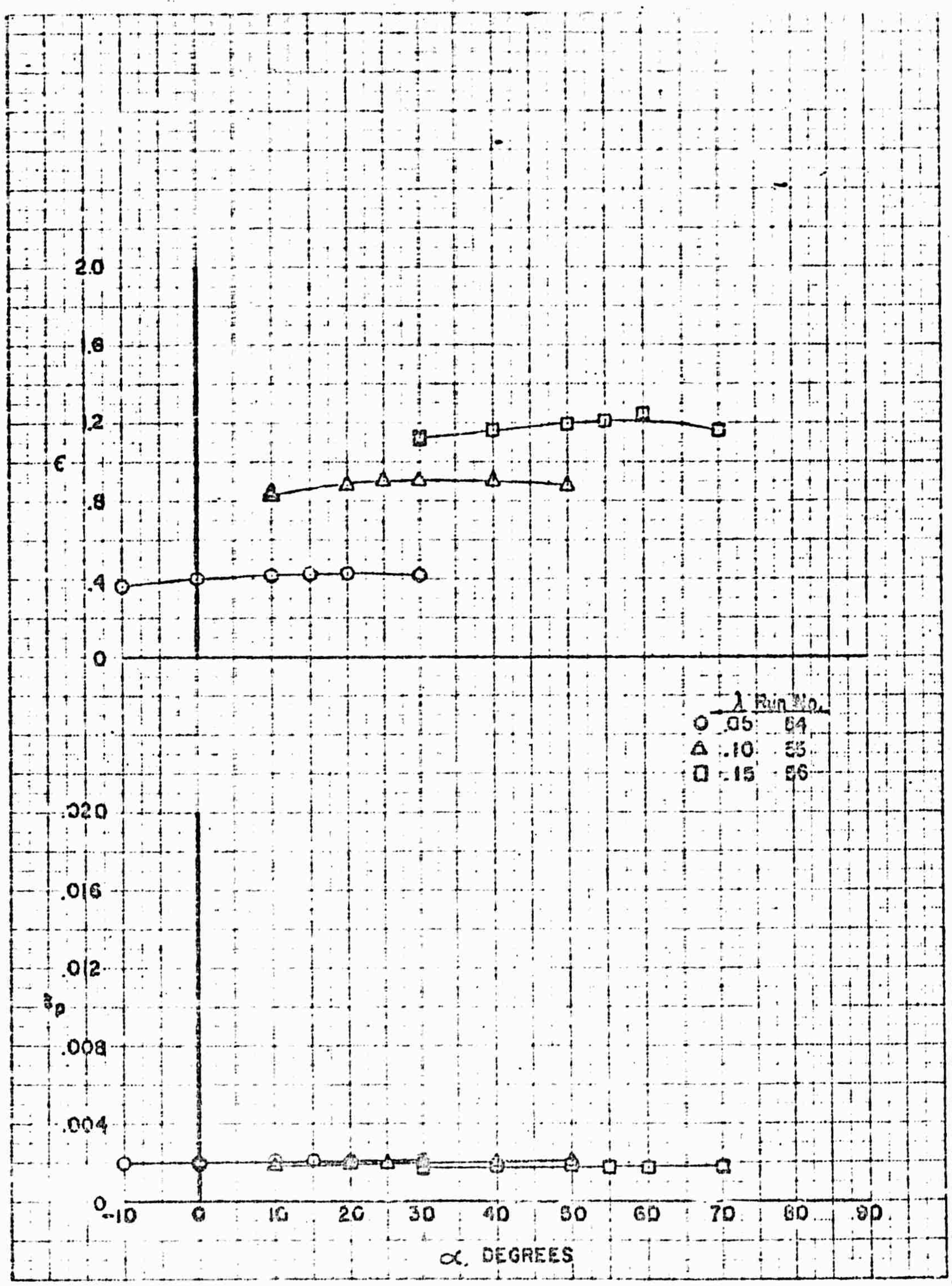


FIGURE 63b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_2P_2S

$\beta = 12°$

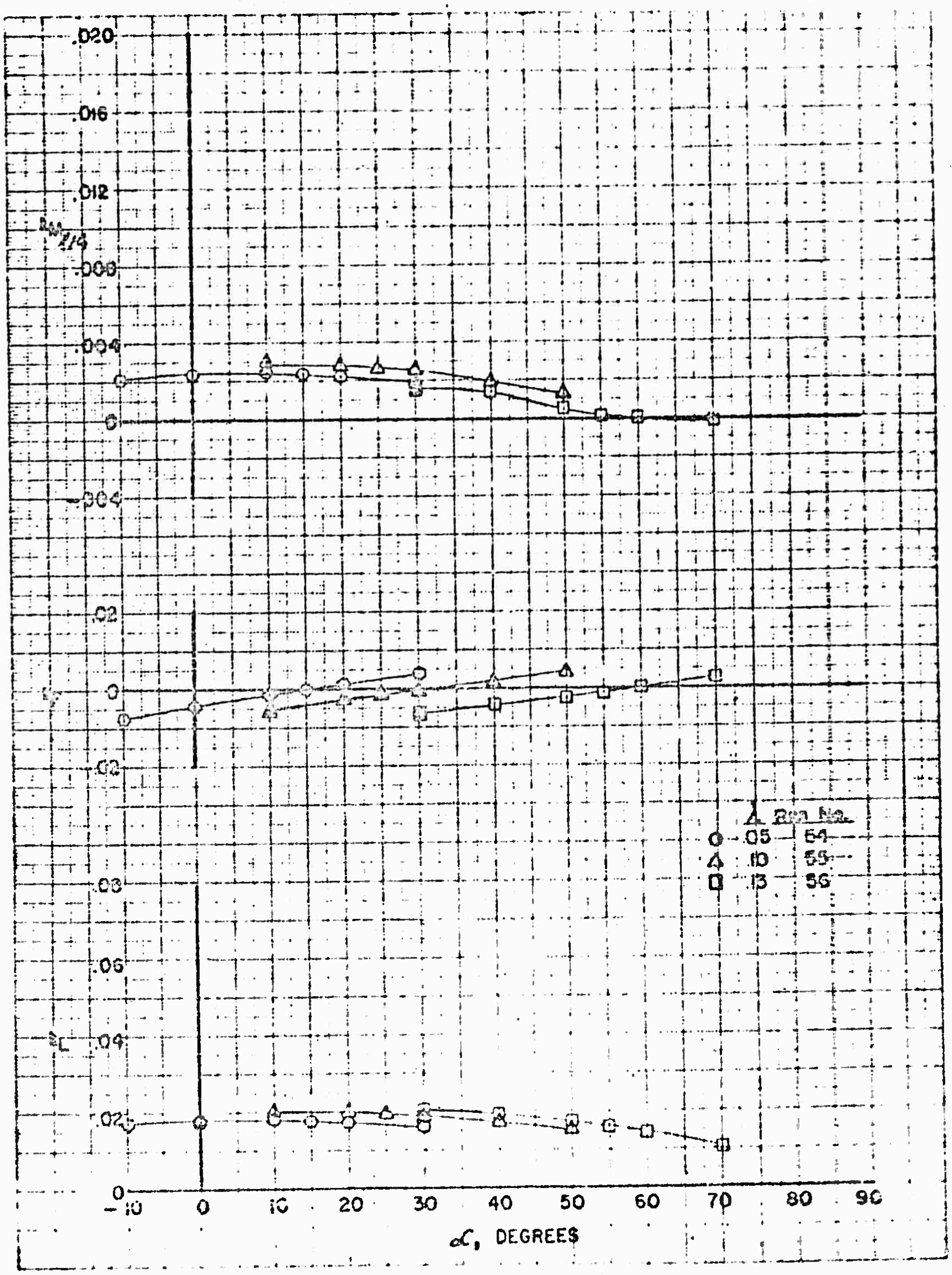


FIGURE 64a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

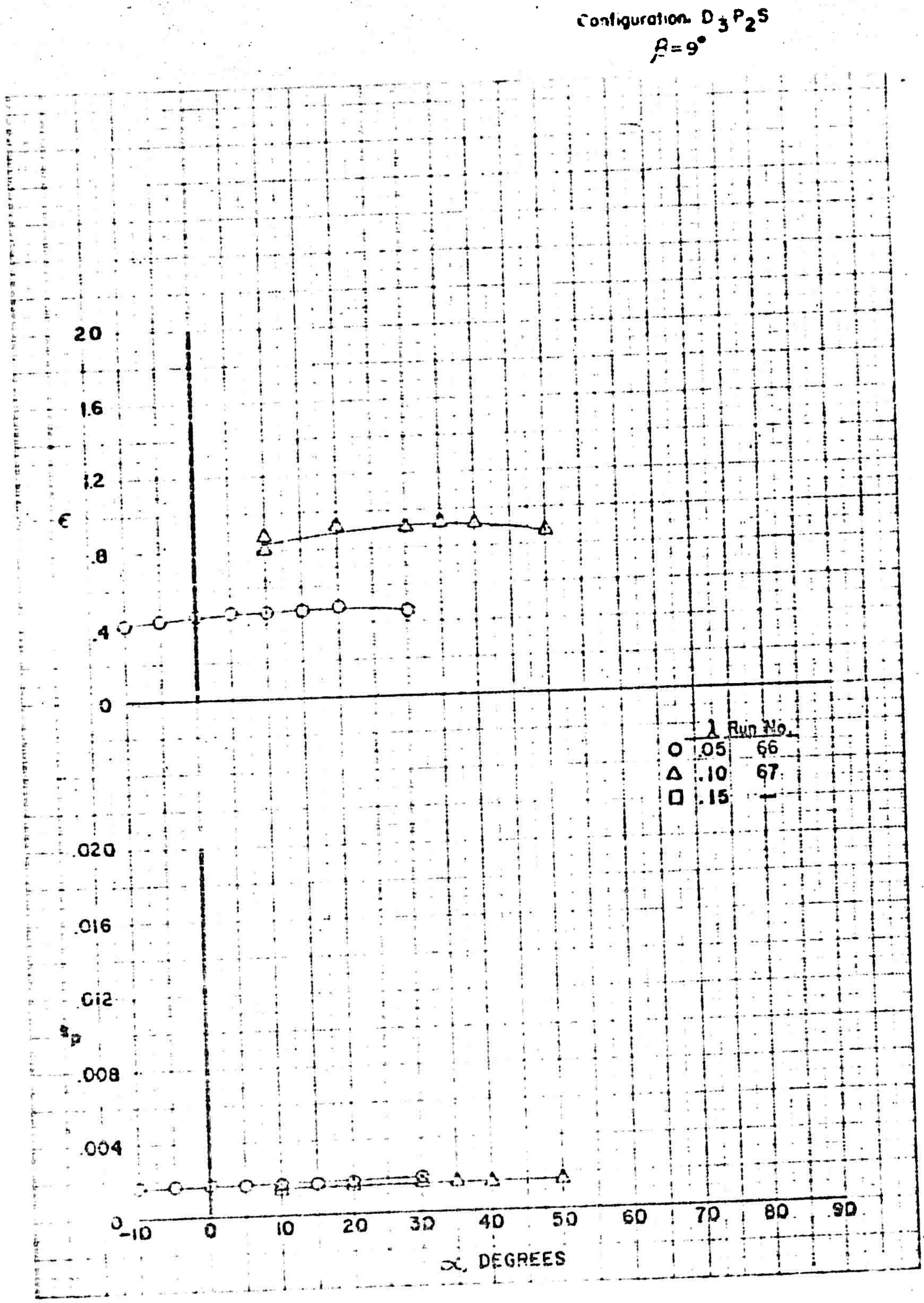


FIGURE 64b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_2S

$\beta = 9°$

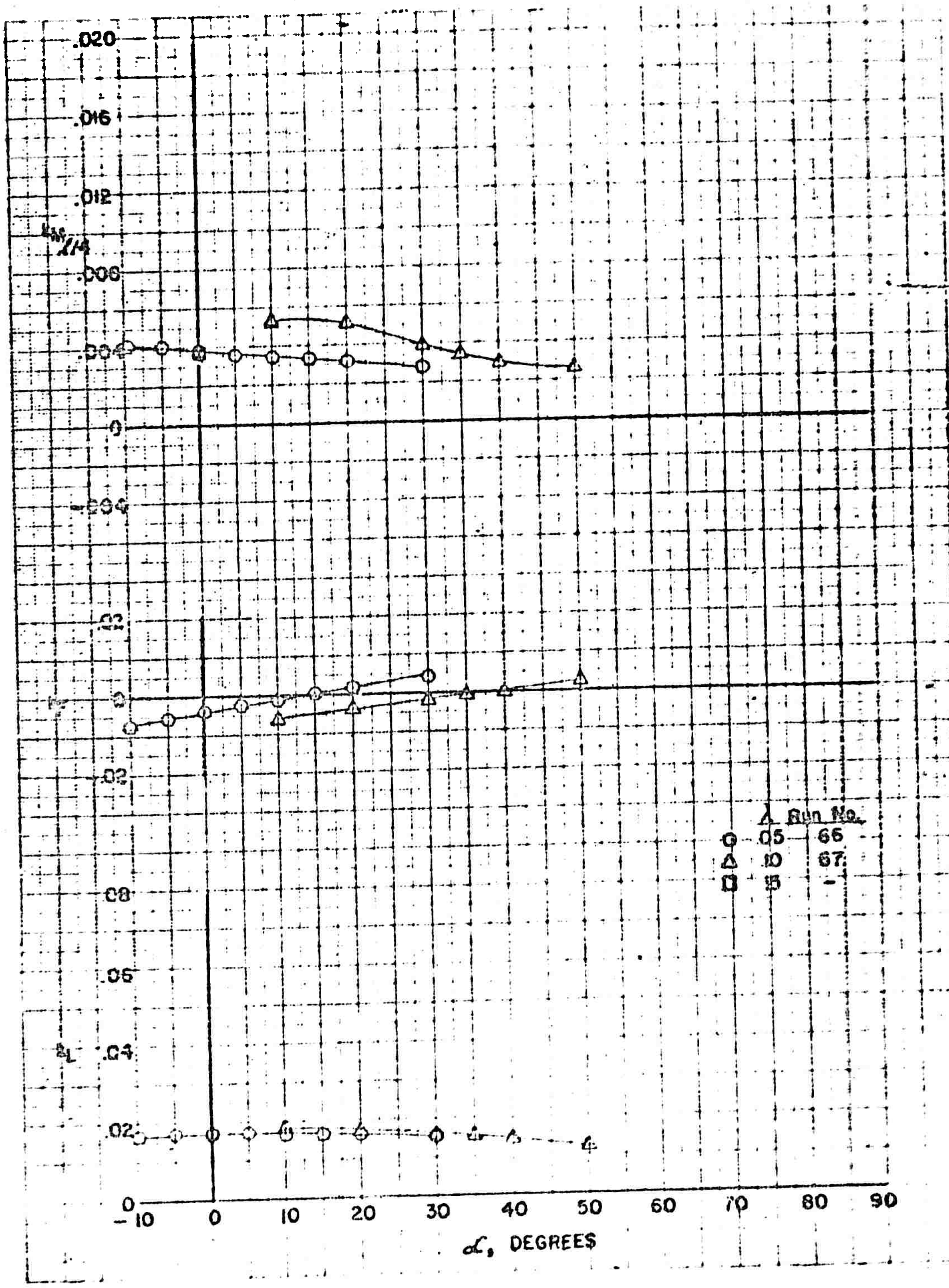


FIGURE 65a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 357 (00) Phase II

Configuration D_3P_2S

$\beta = 12°$

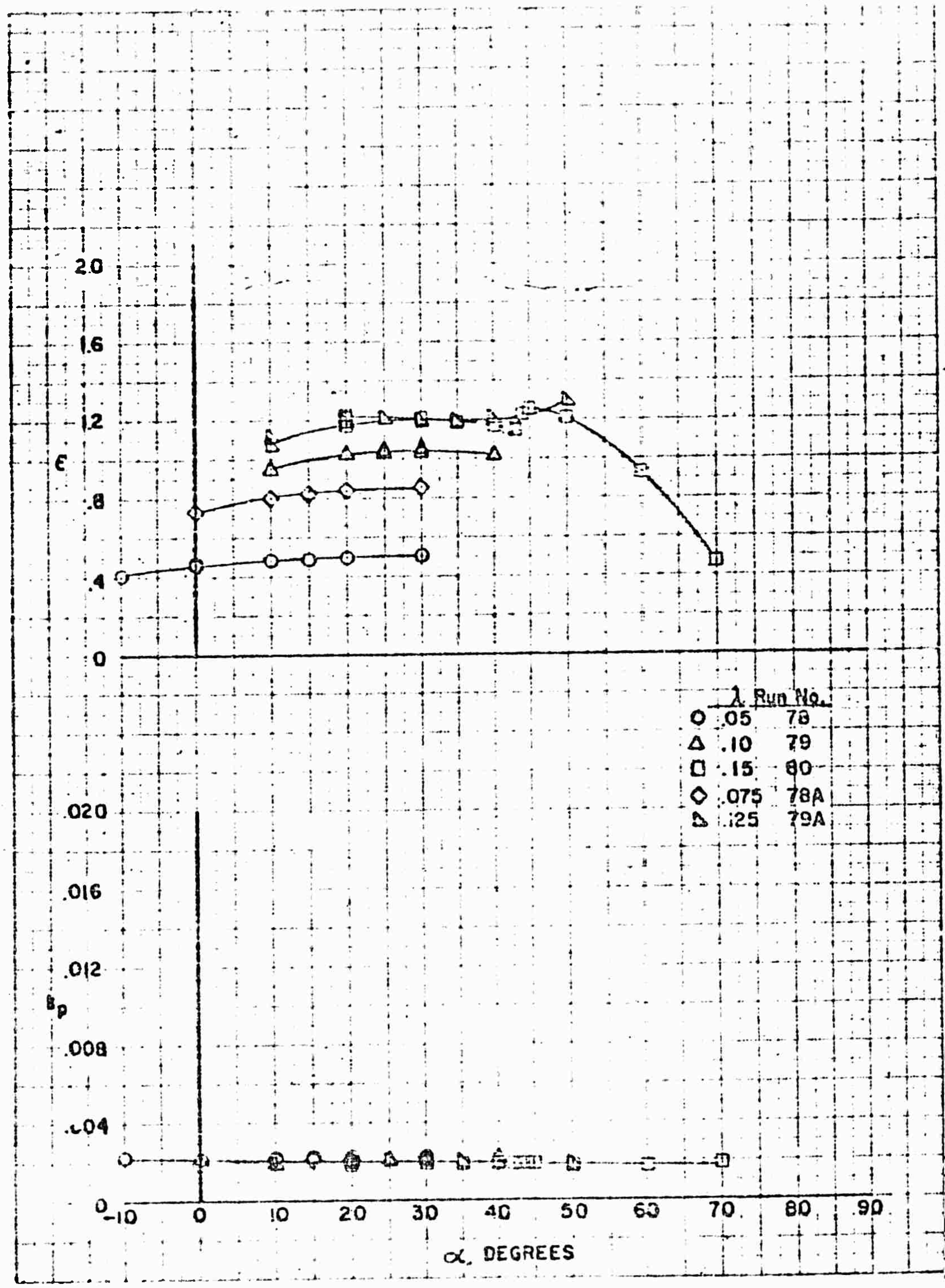


FIGURE 65b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S

$\beta = 12°$

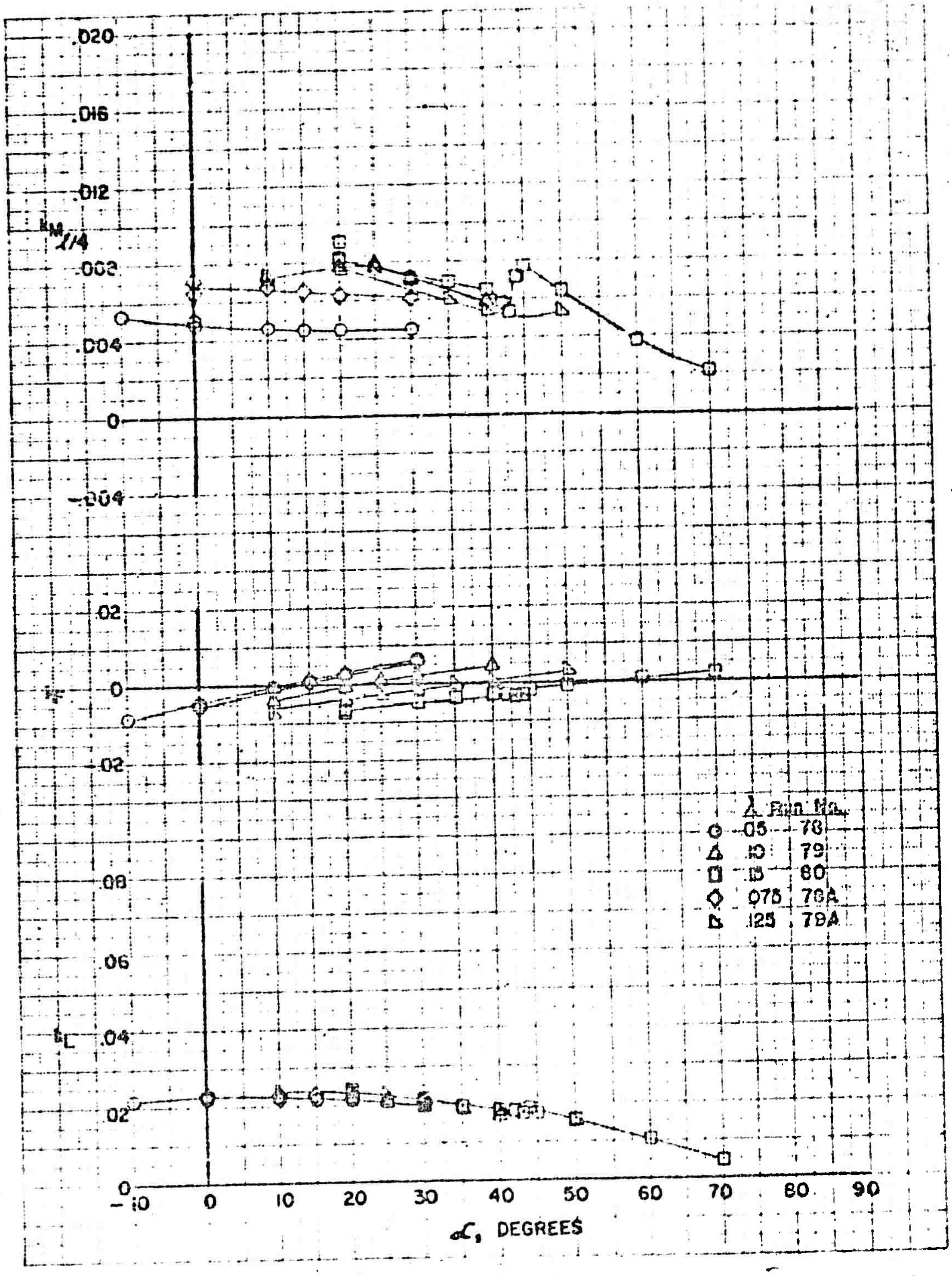


FIGURE 66a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_2S

$\beta = 18°$

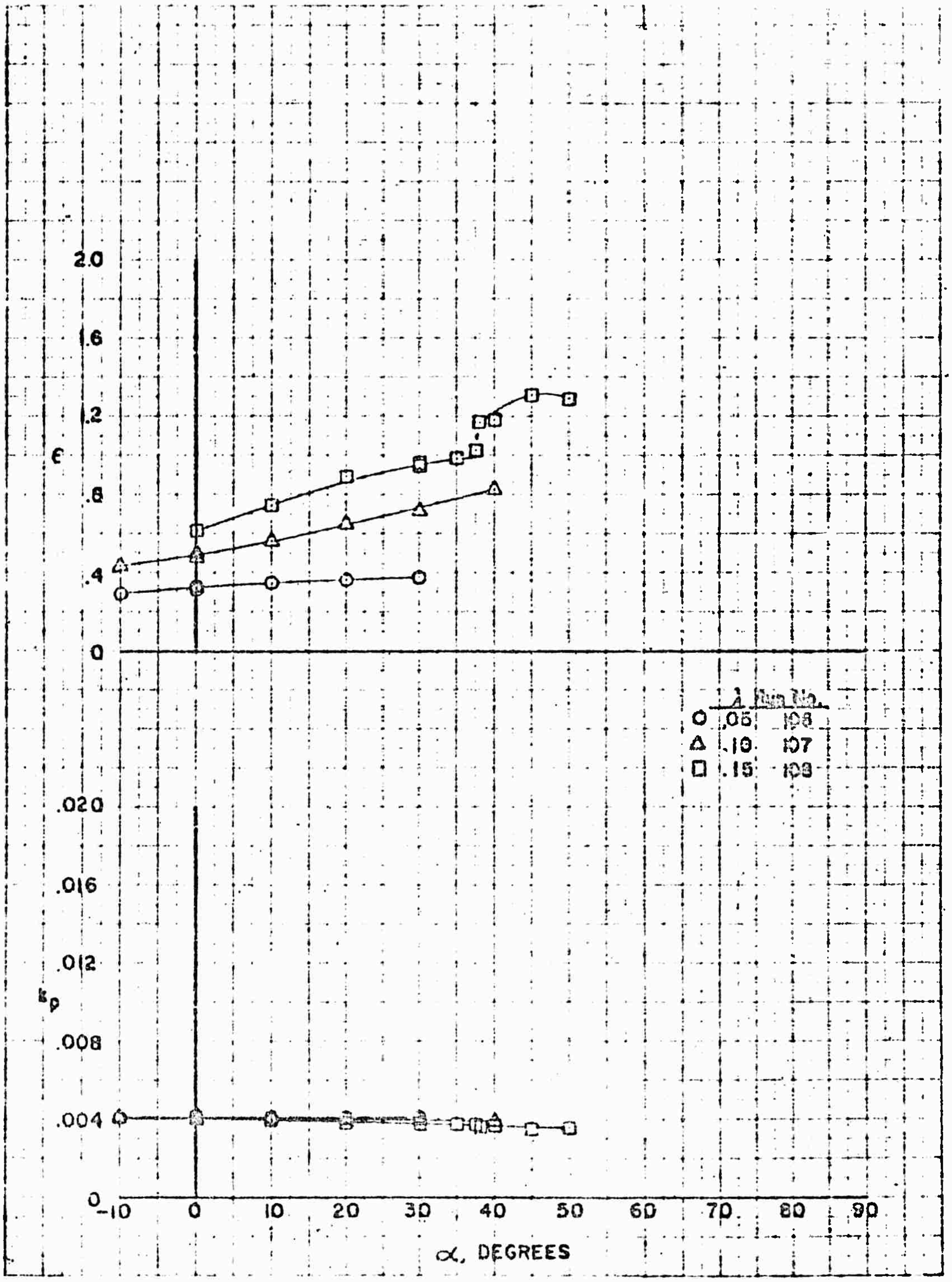


FIGURE 66b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

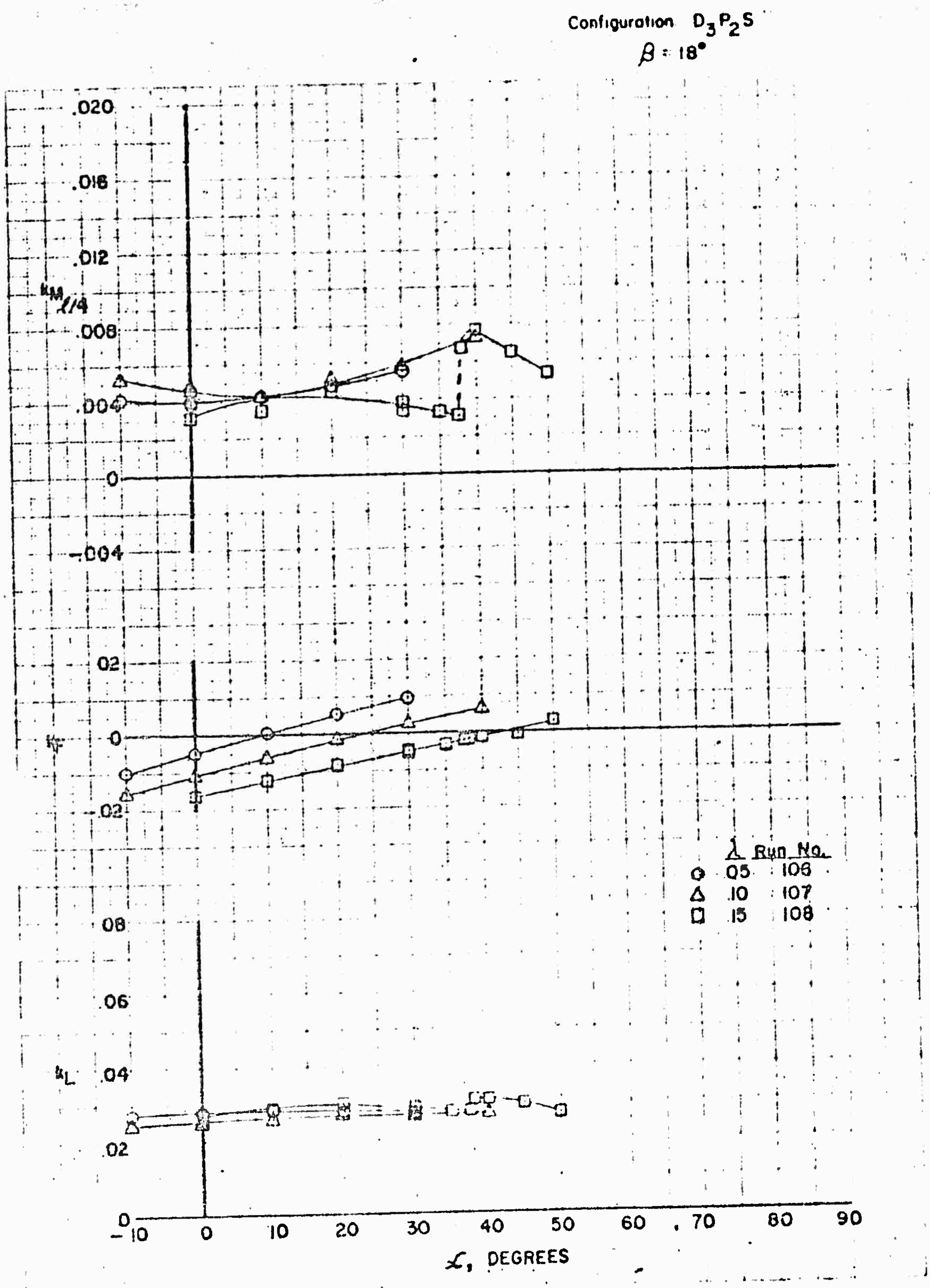


FIGURE 67a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_2S

$\beta = 12°$

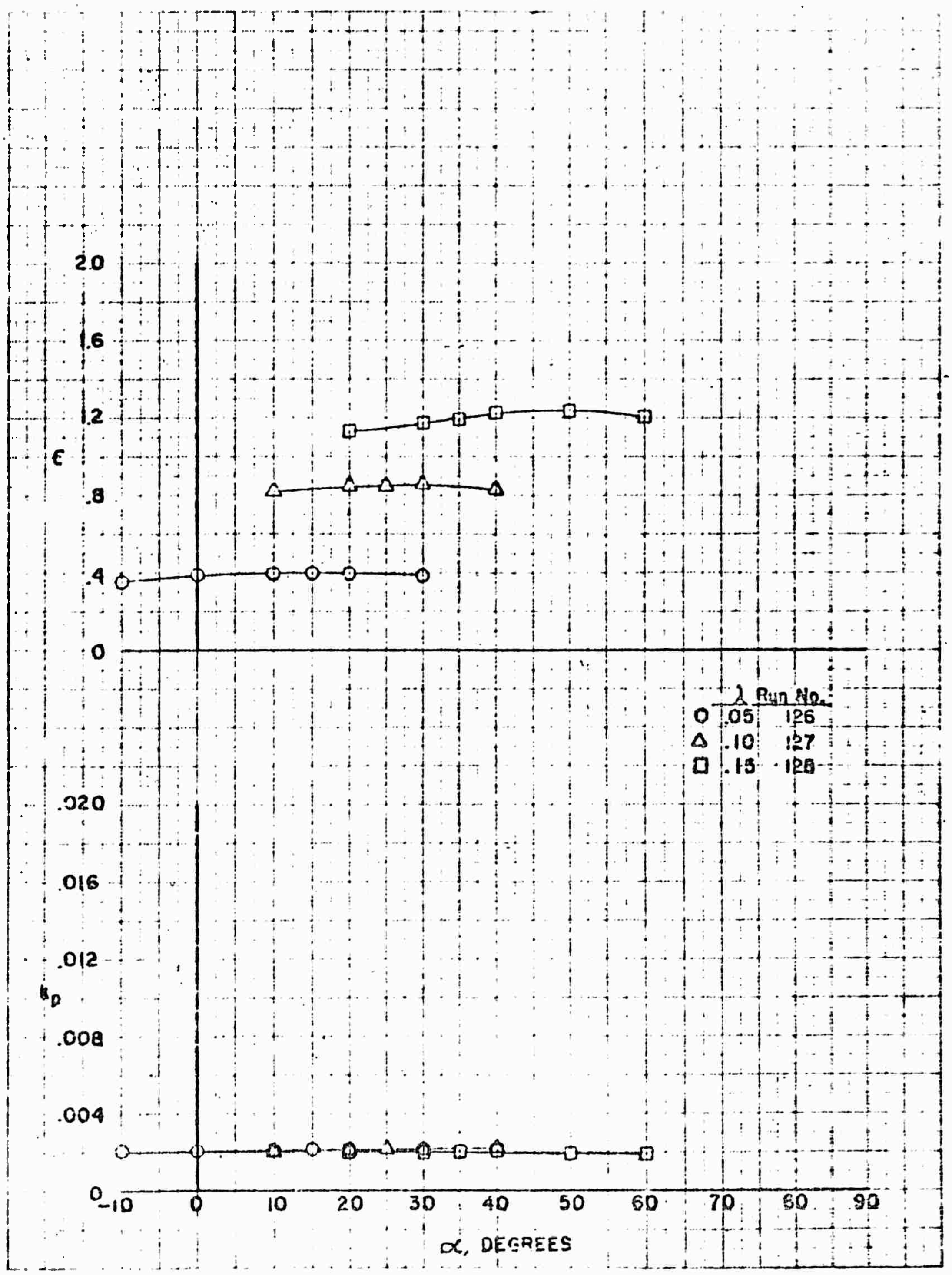


FIGURE 67b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_2S

$\beta = 12°$

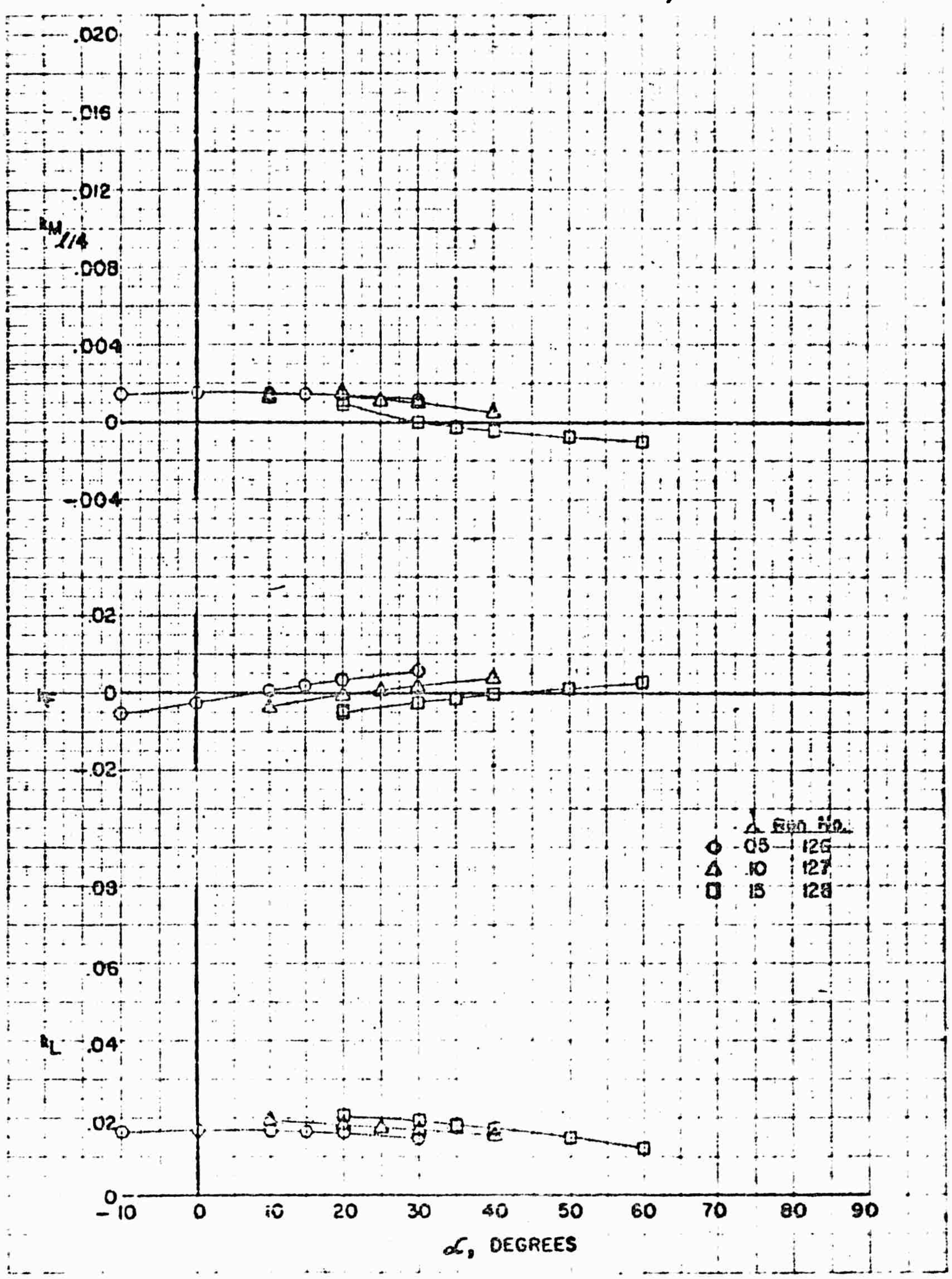


FIGURE 68a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_pS

$\beta = 12°$

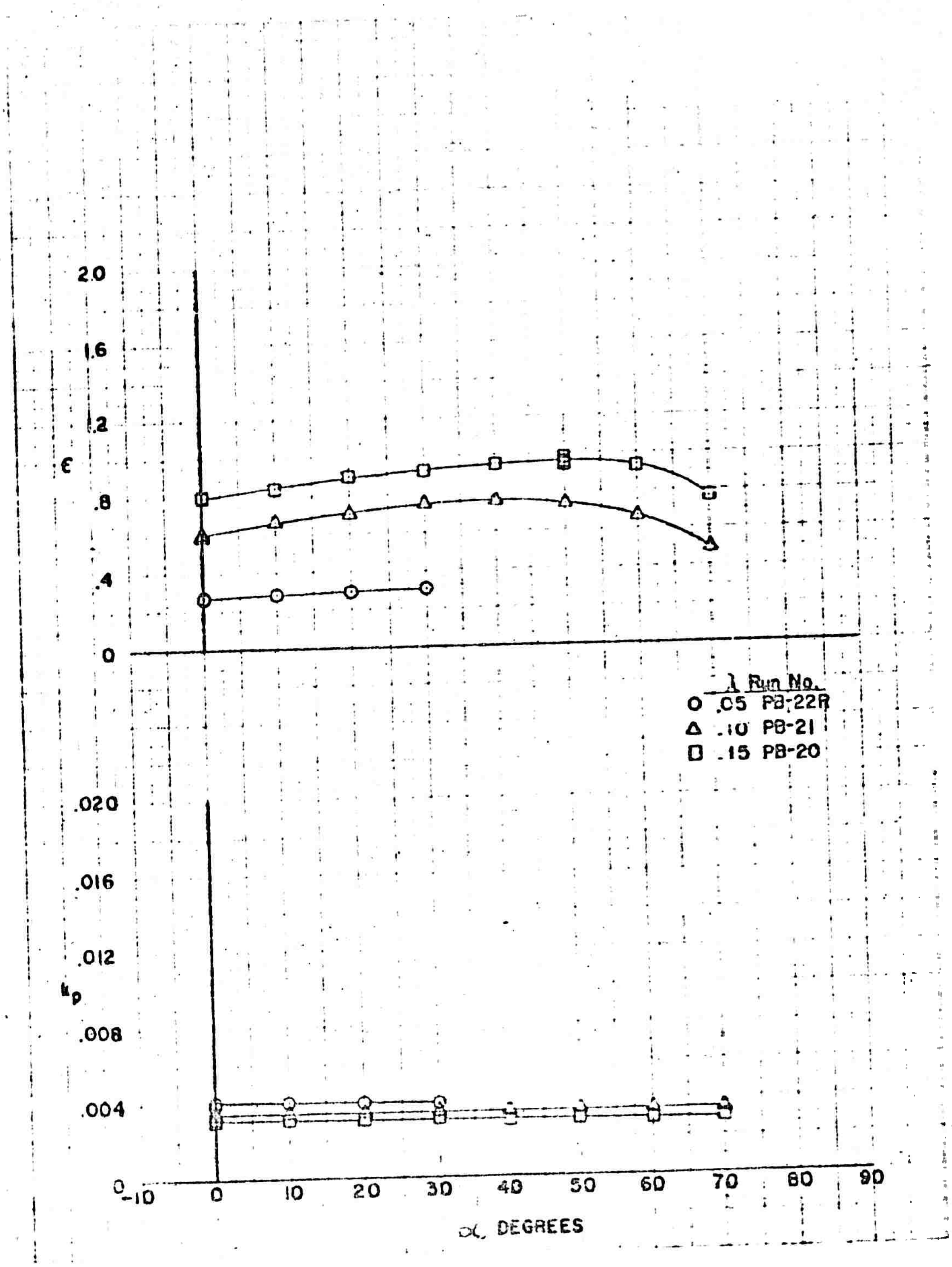


FIGURE 237 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D

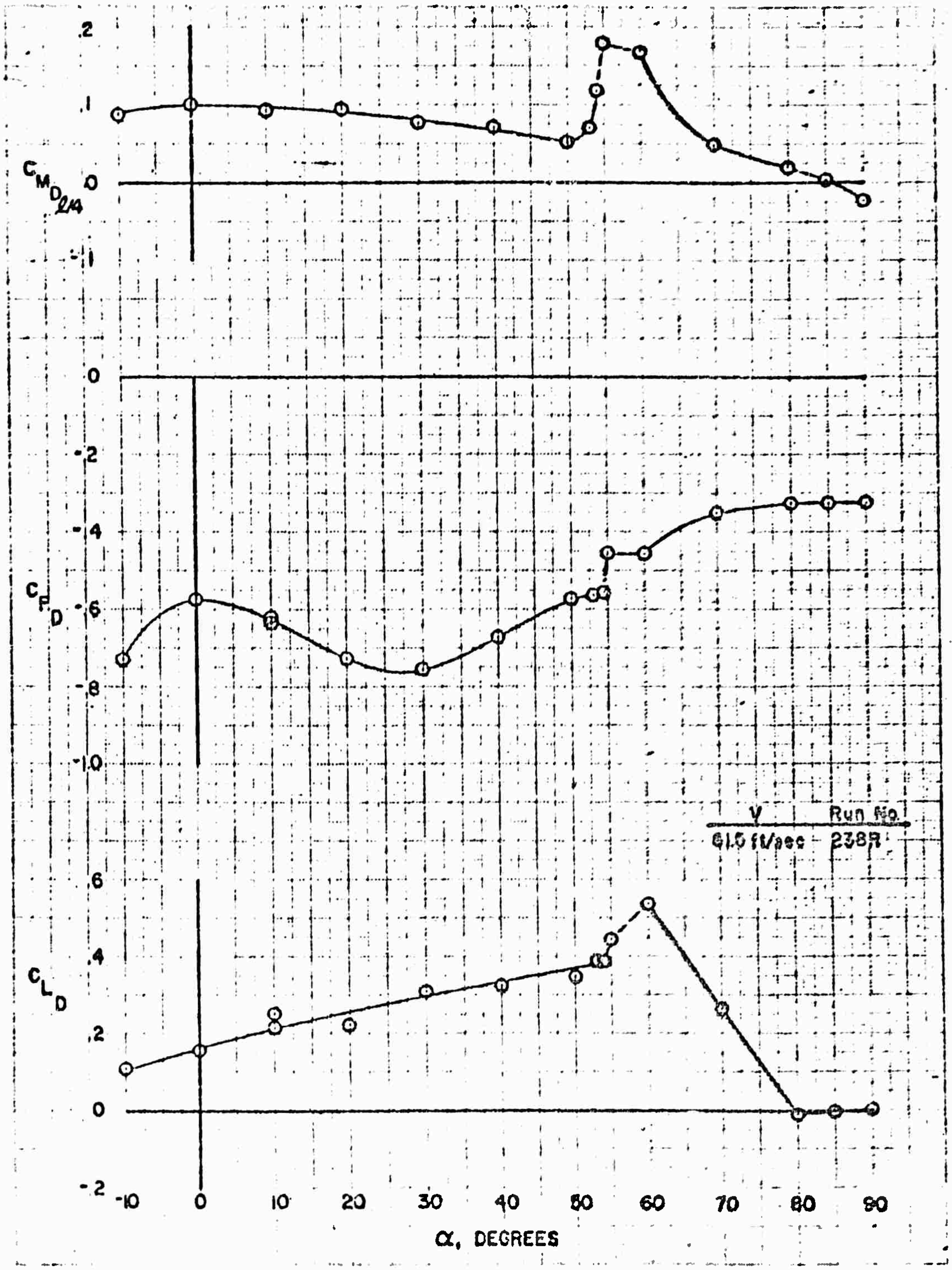
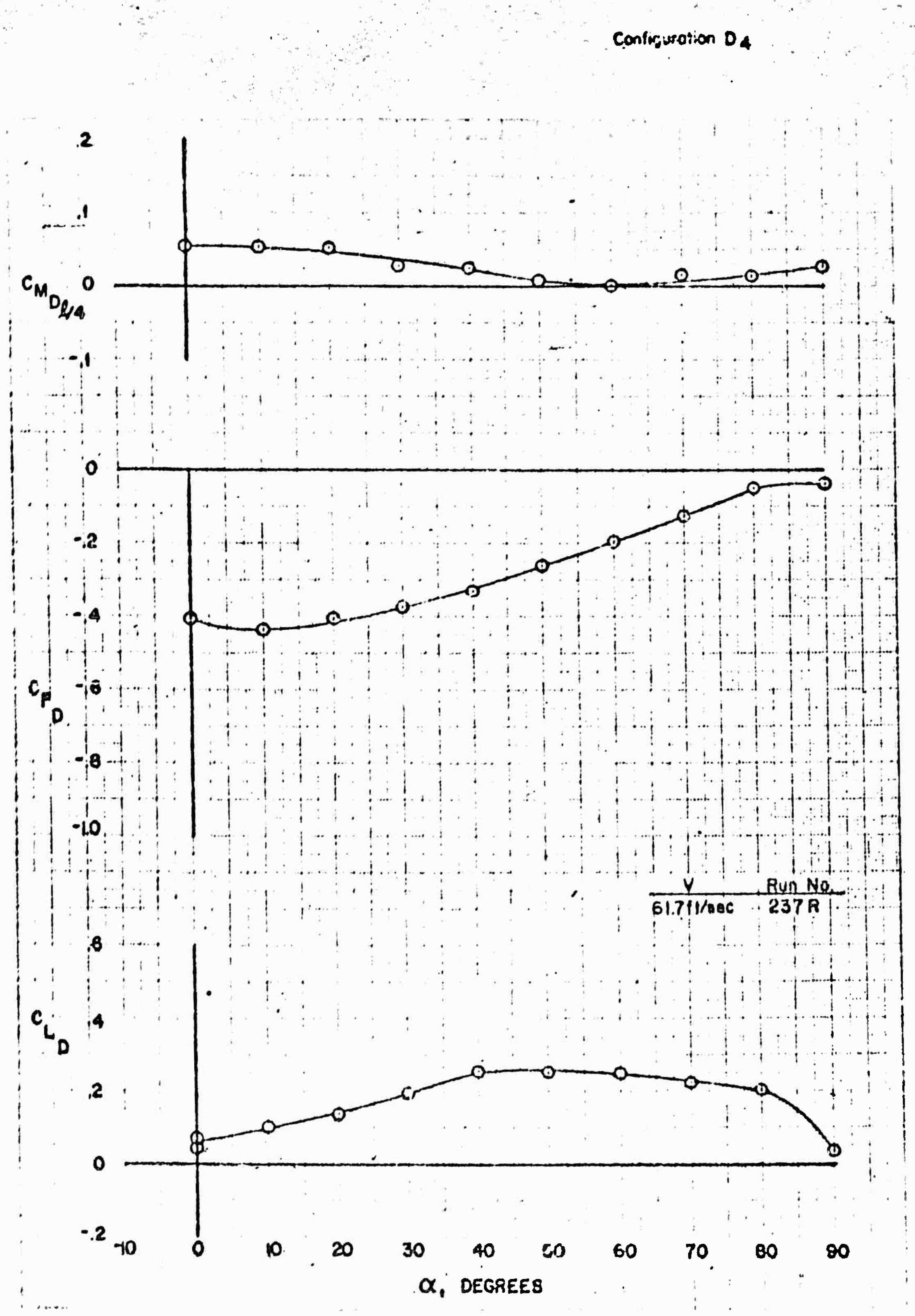


FIGURE 238 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV



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1. Originating Agency and/or Monitoring Agency:

   O.A.: Hiller Aircraft Corporation, Palo Alto, California
   M.A.: Office of Naval Research, Air Branch, Washington 25, D. C.

2. Originating Agency and/or Monitoring Agency Report Number:

   O.A.: Report No. ARD-224

3. Title and Classification of Title: Unclassified

   Wind Tunnel Tests of Several Ducted Propellers in Non-Axial Flow

4. Personal Author: Aerophysics Department, W. J. Gill

5. Date of Report: 20 April 1959

6. Pages: 36

7. Illustrative Material: Eight (8) Tables; Two Hundred Thirty Eight (238) Figures

8. Prepared for Contract No.: Nonr 1357(00), Phase IV

9. Prepared for Project No.: NR 212-039/12-5-56

10. Security Classification: Unclassified

11. Distribution List: See attached list

12. Abstract:

Data report, plots and discussion of results of wind tunnel tests of several ducted propellers in non-axial flow. Tests performed at David Taylor Model Basin.

FIGURE 685 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_2 P_p S$

$\beta = 12°$

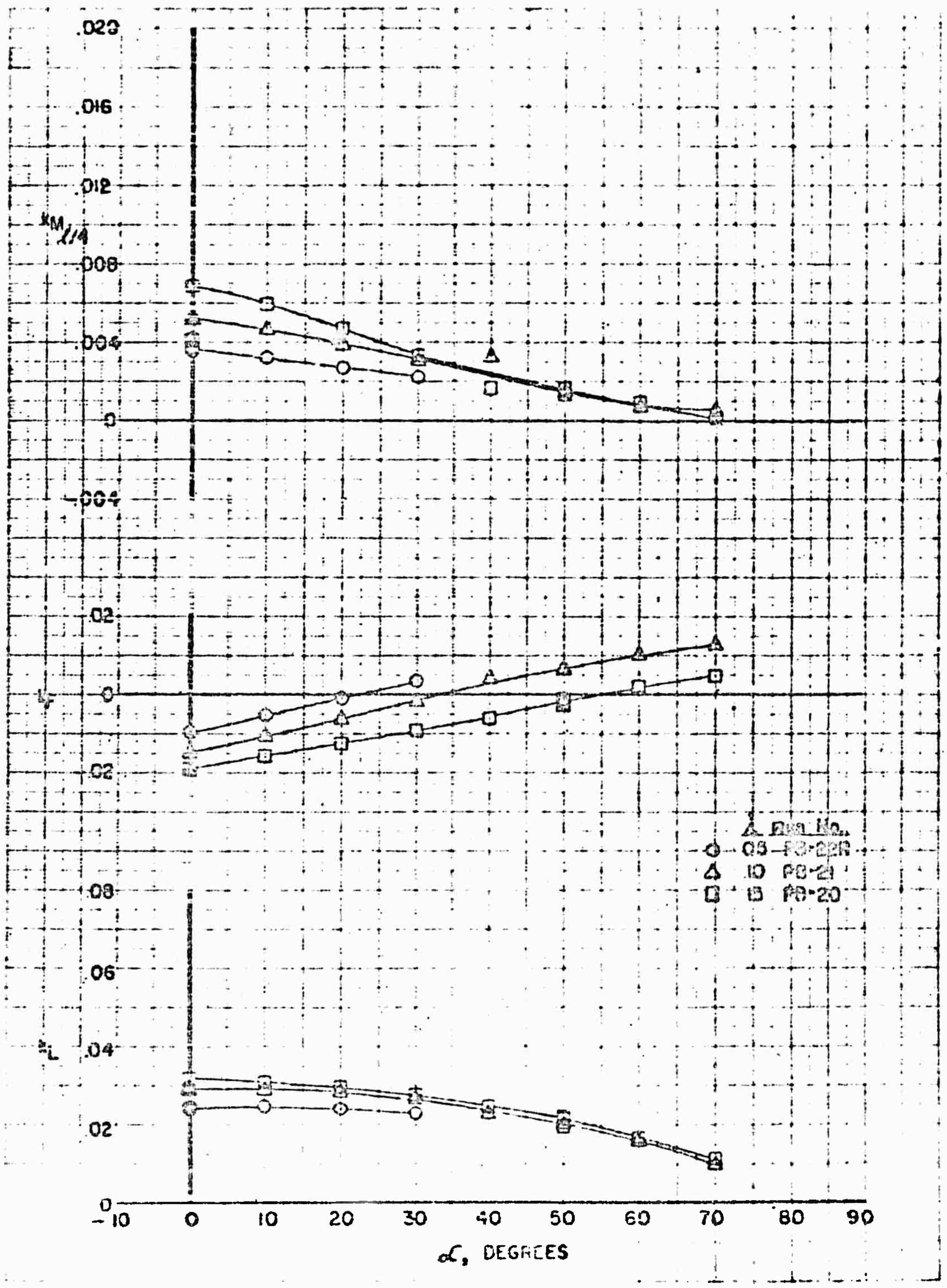

FIGURE 69a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

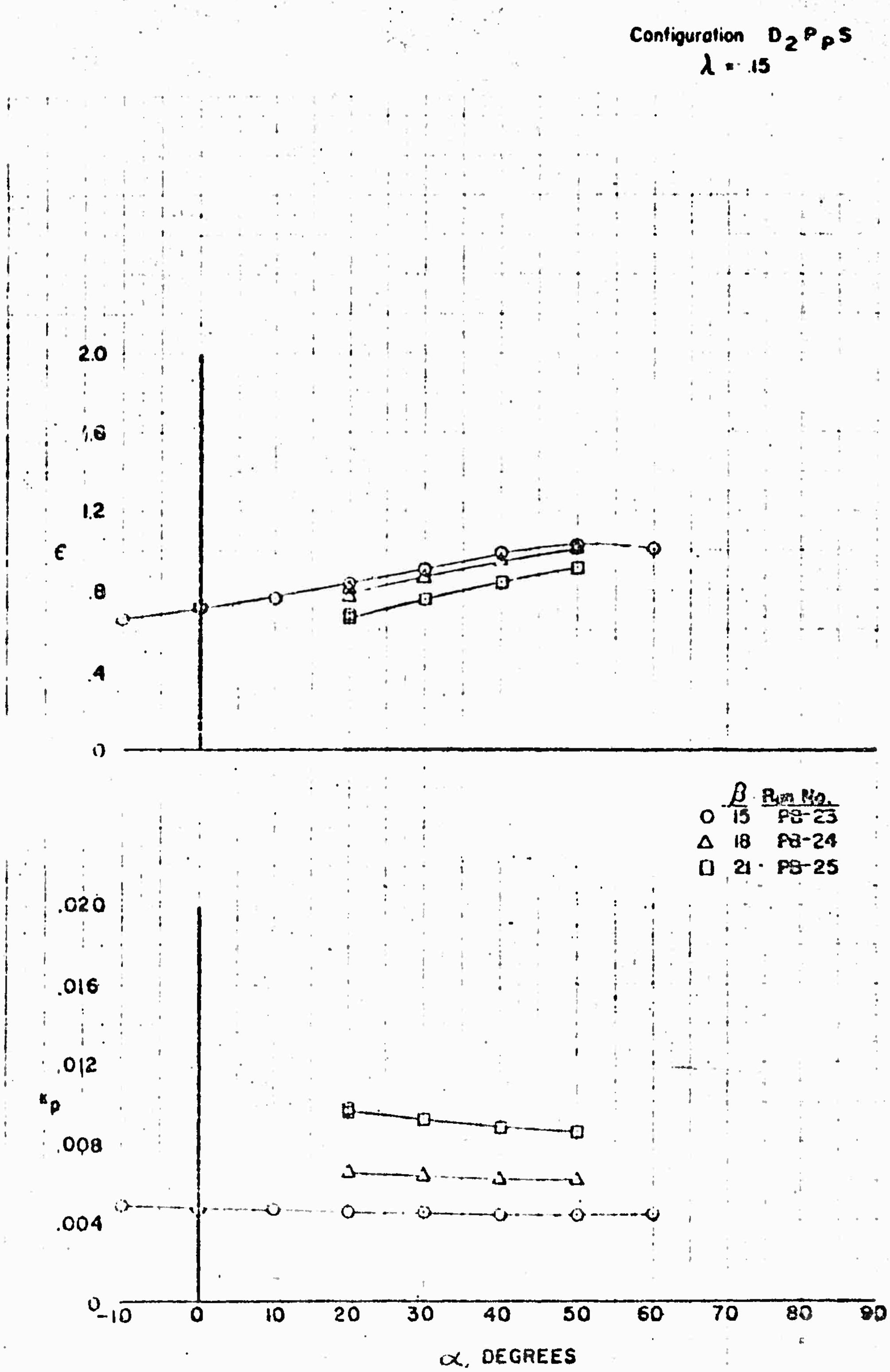

FIGURE 69b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2PpS

$\lambda = .15$

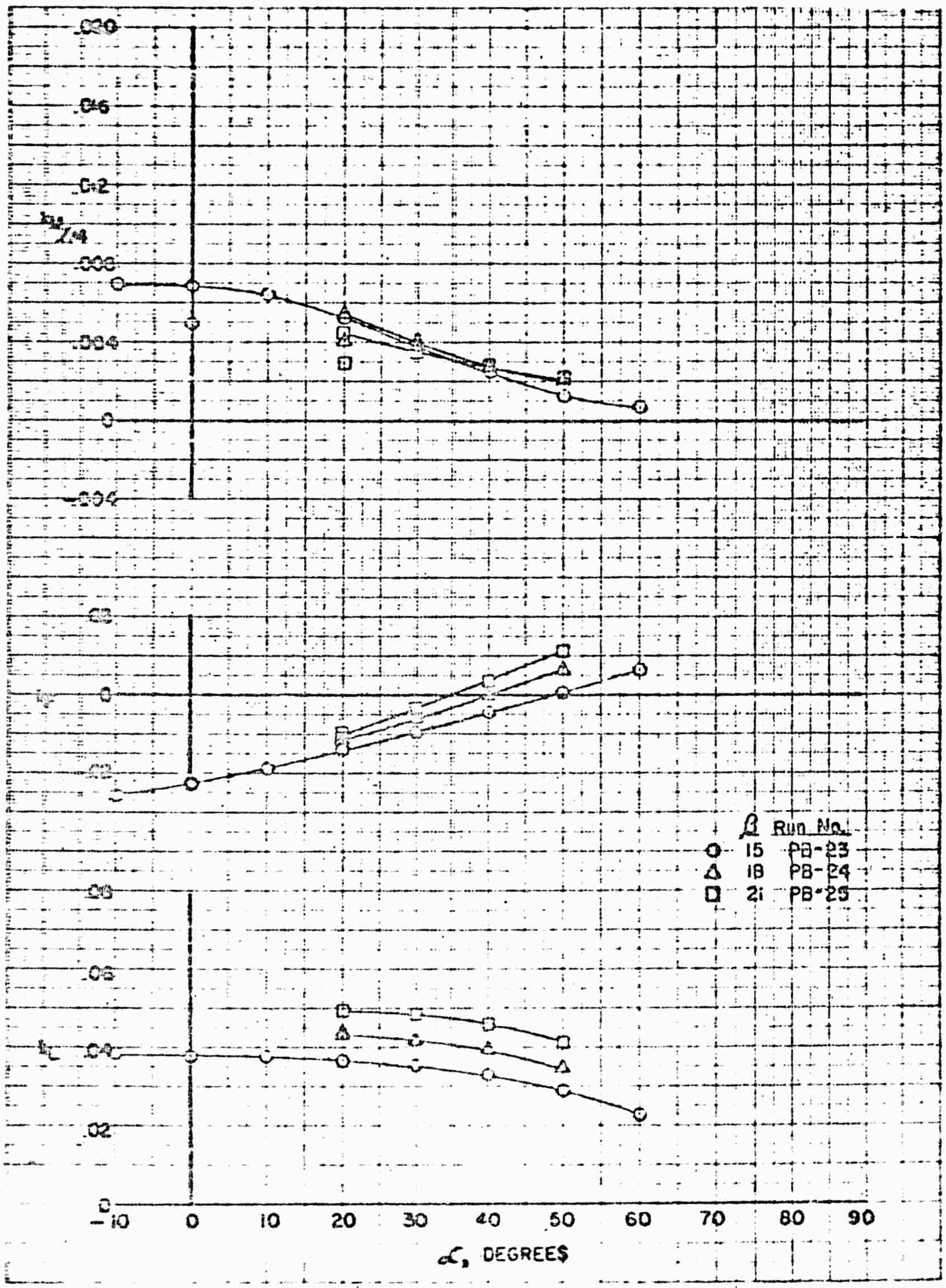

FIGURE 70a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_pS

$\lambda = .15$

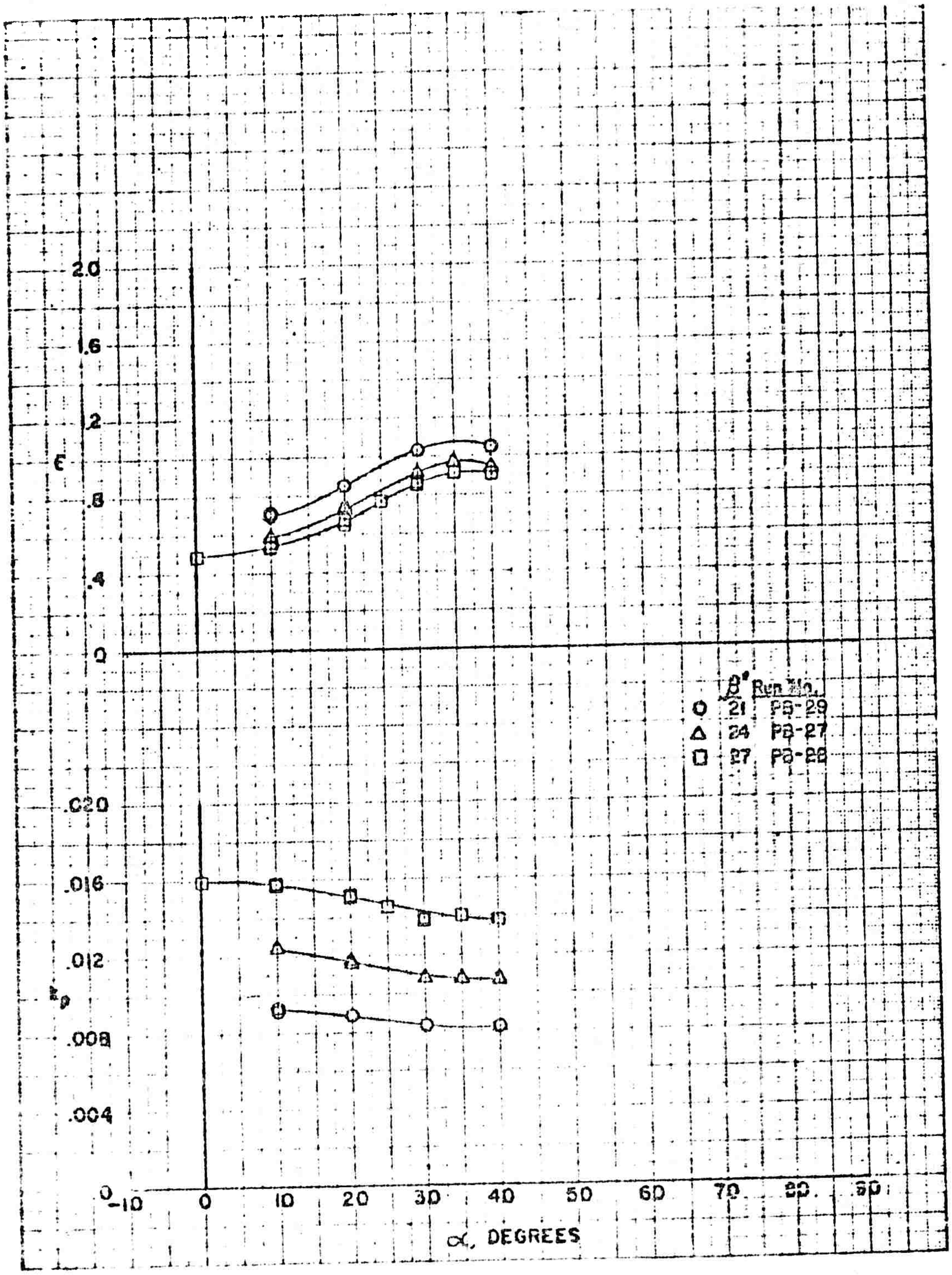

FIGURE 70b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_pS

$\lambda = .15$

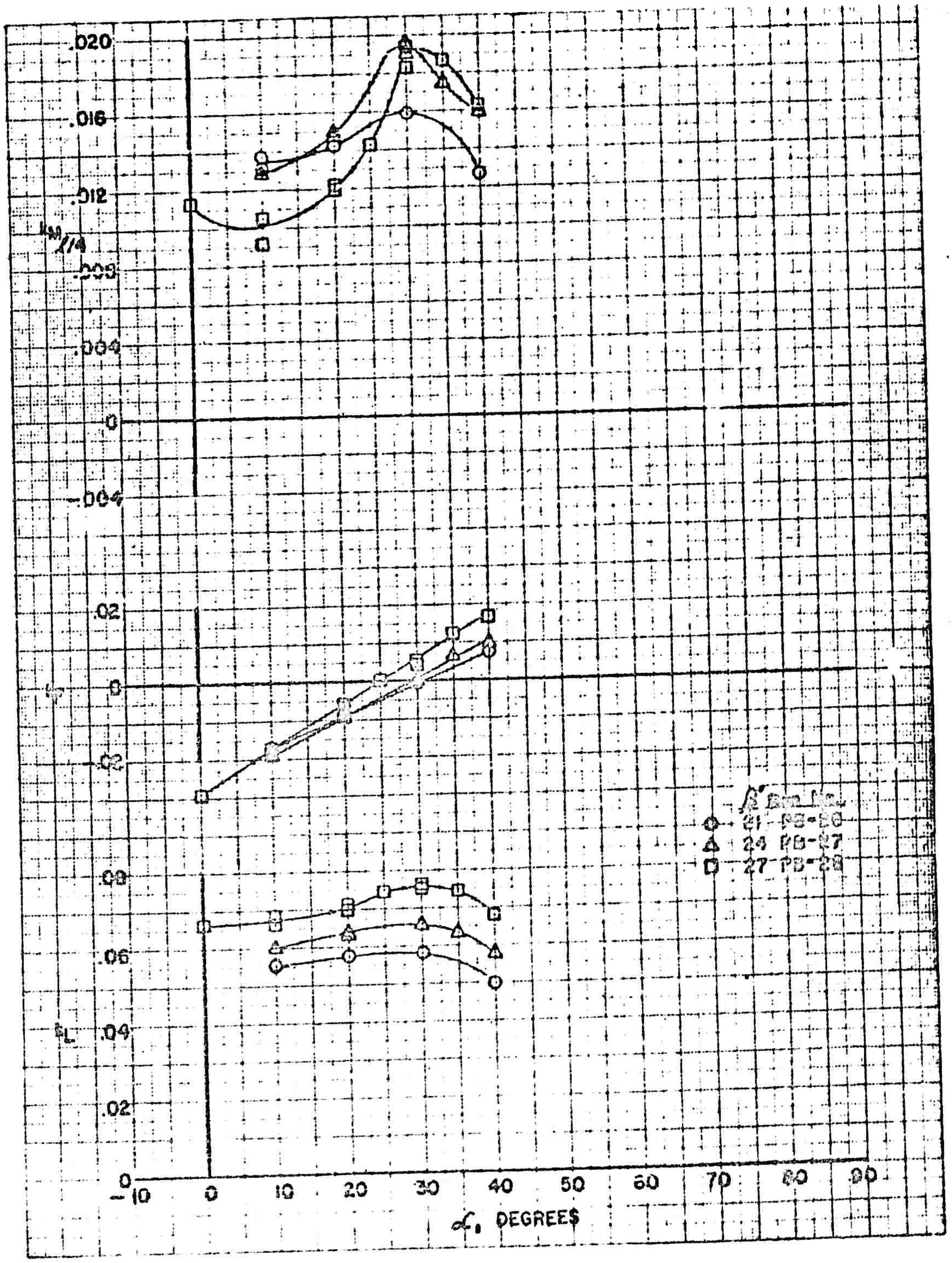

FIGURE 71a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV.

Configuration P_3S

$\beta = 9°$

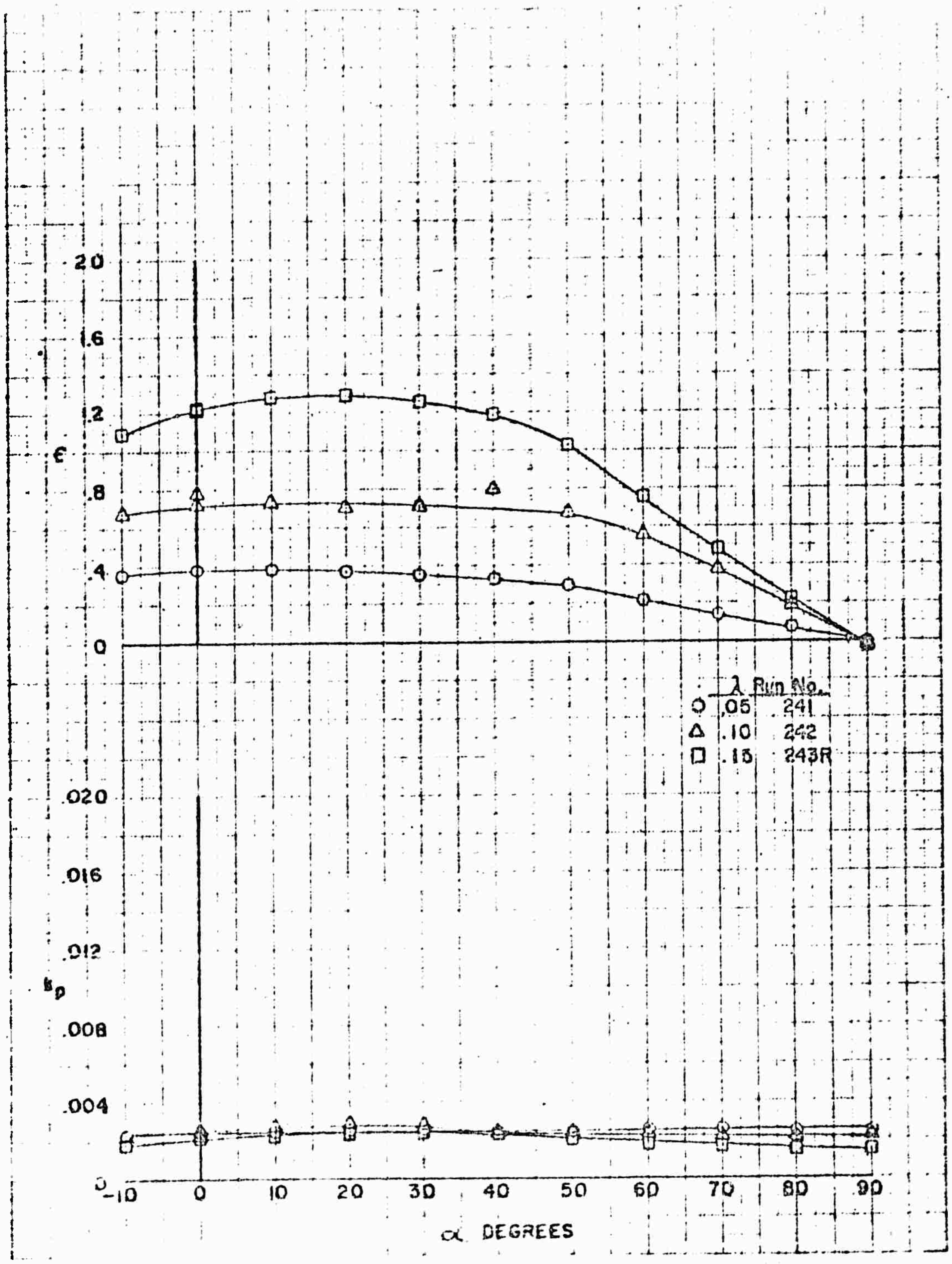

FIGURE 71b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration P_3S

$\beta = 9°$

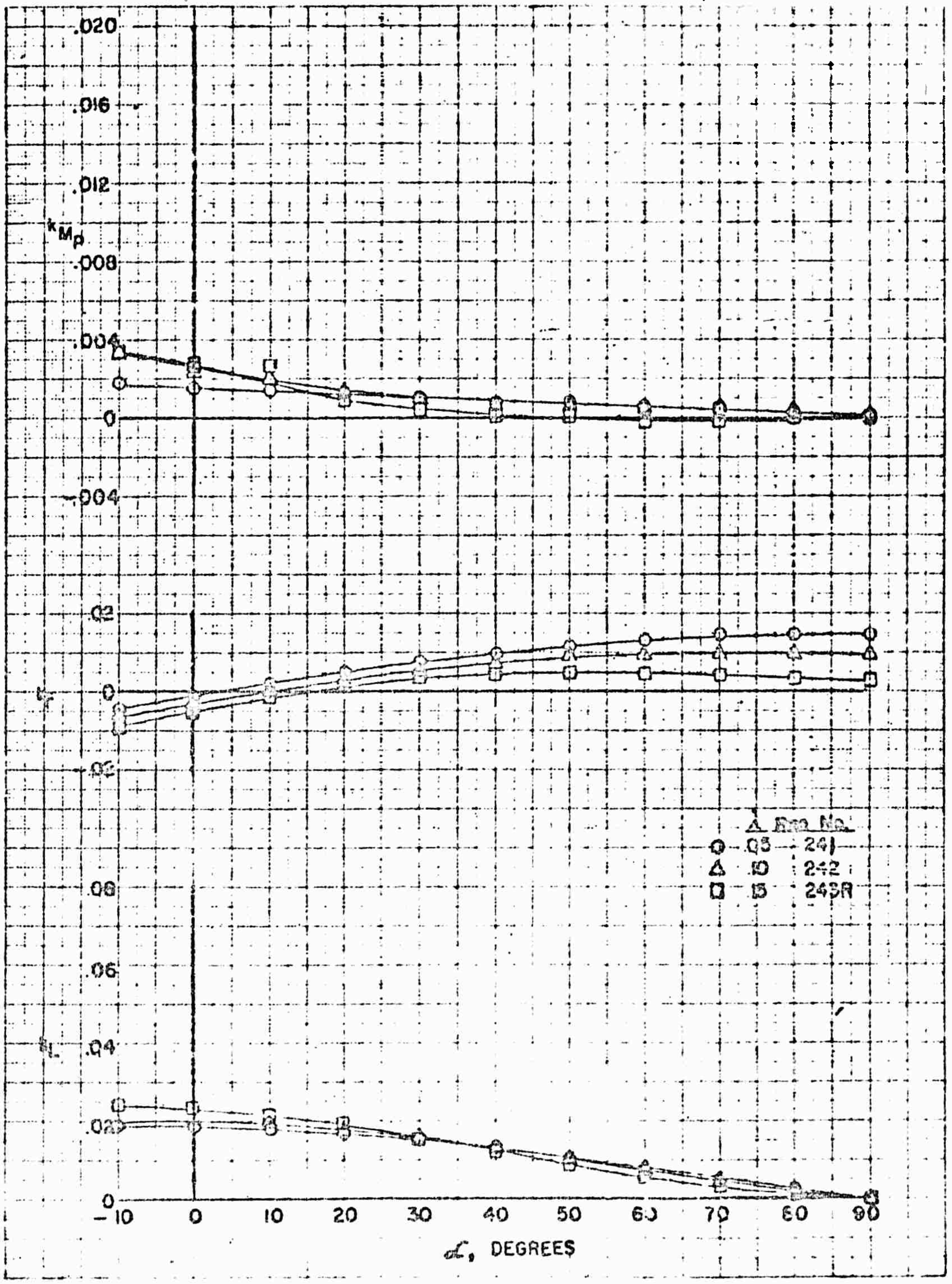

FIGURE 72a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1507 (00) Phase IV

Configuration P_3S

$\beta = 12°$

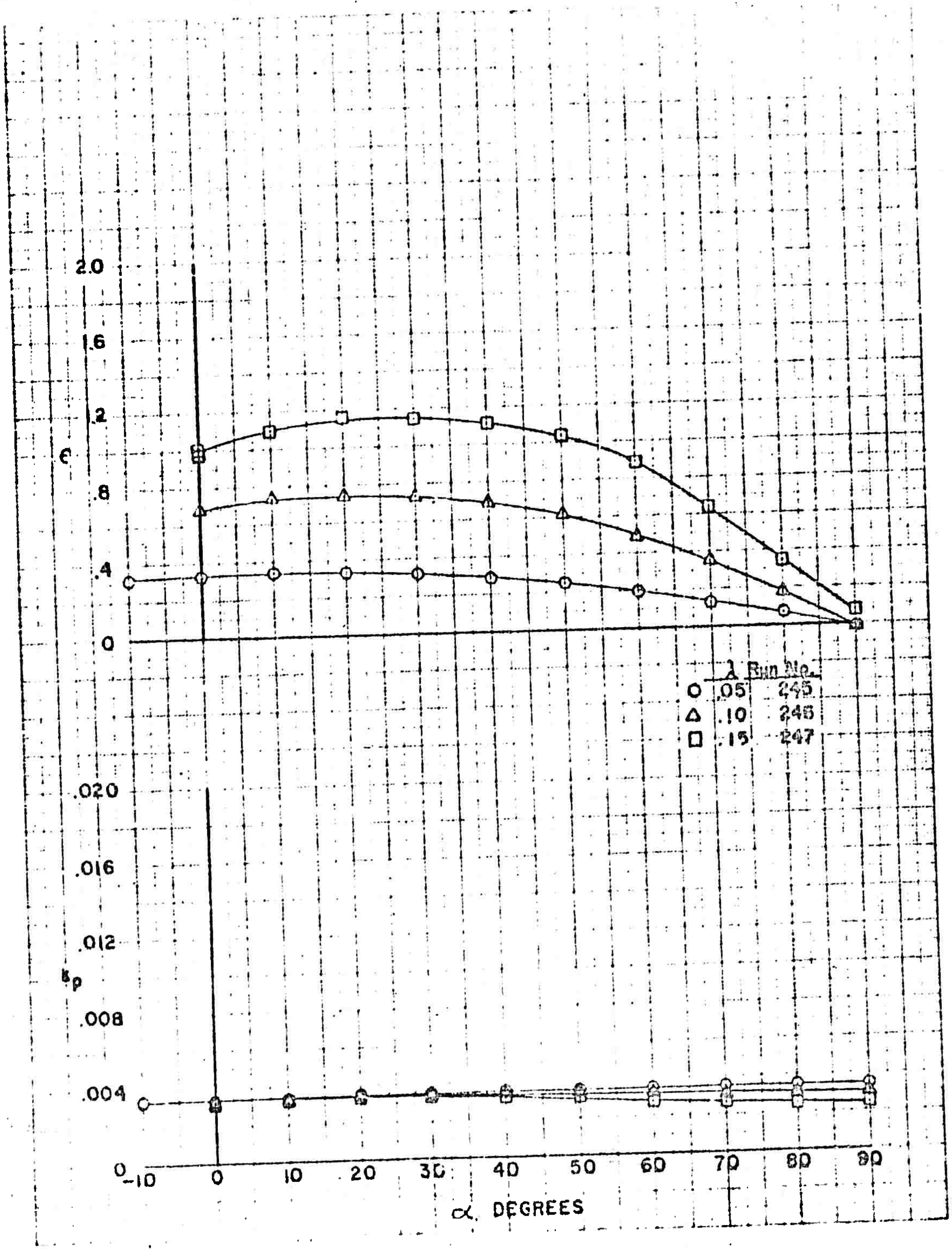

FIGURE 72b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

Configuration P_3S

$\beta = 12^\circ$

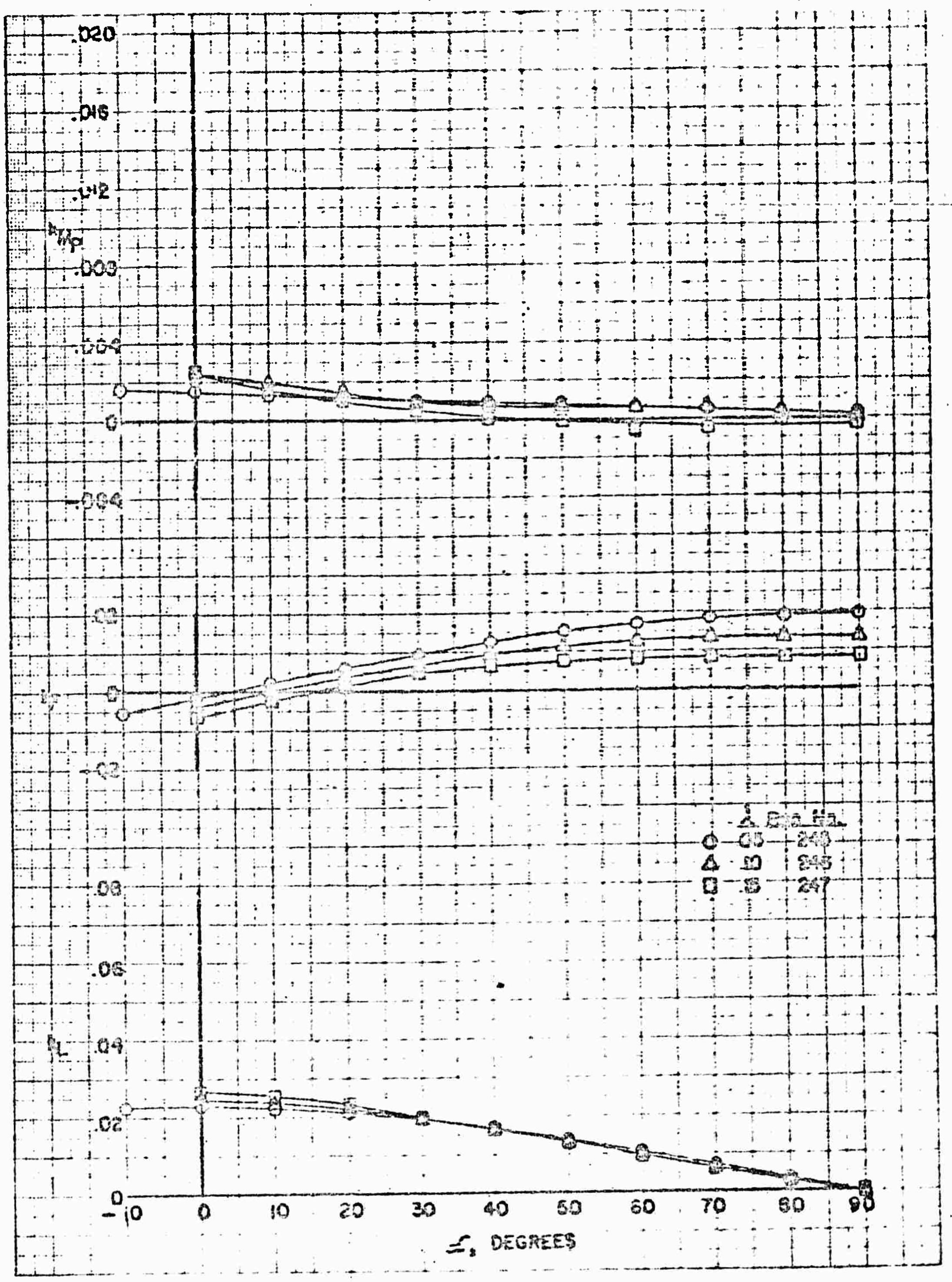

FIGURE 73a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration P_3S

$\beta = 18°$

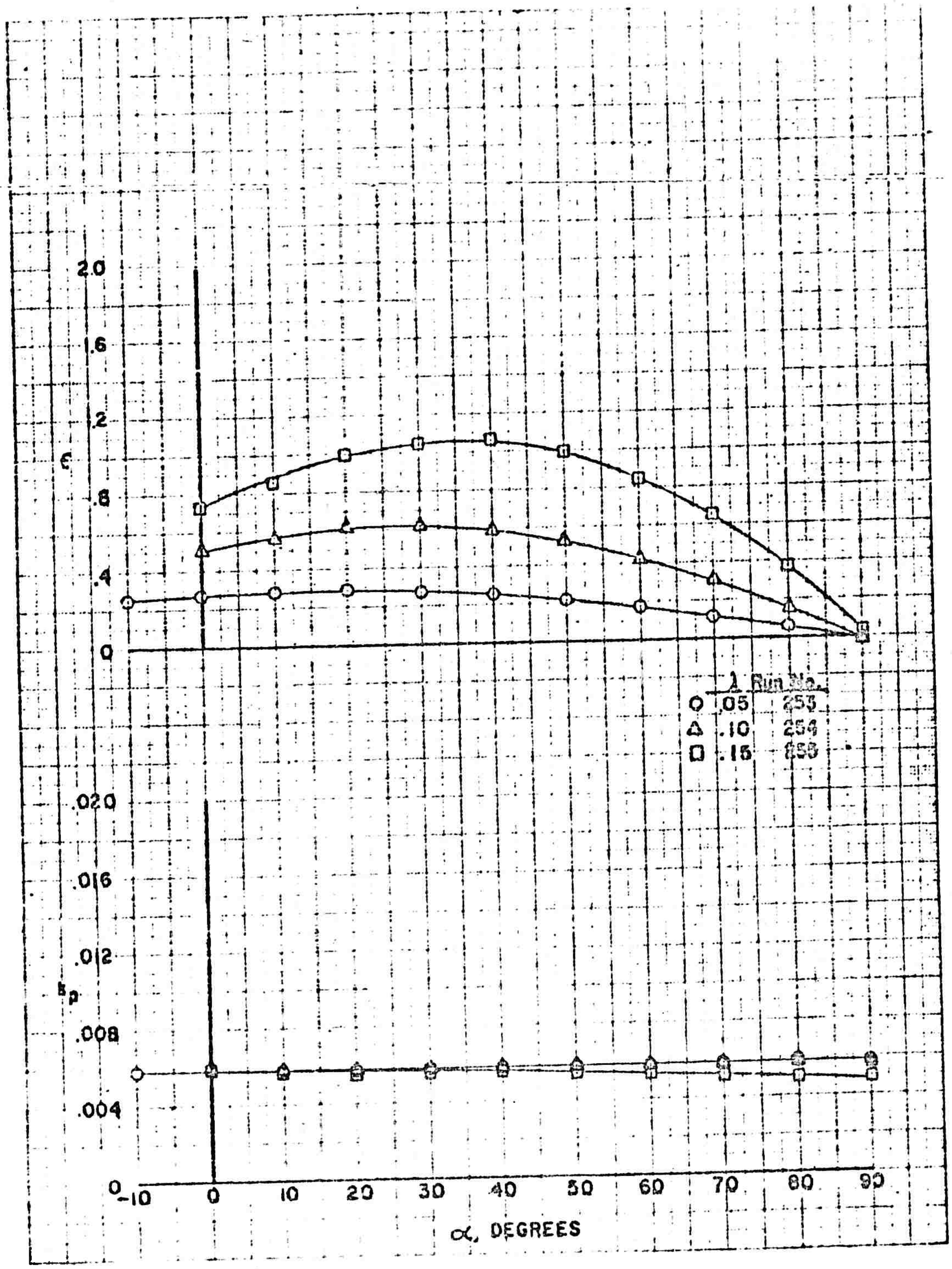

FIGURE 73b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration P_3S

$\beta = 18°$

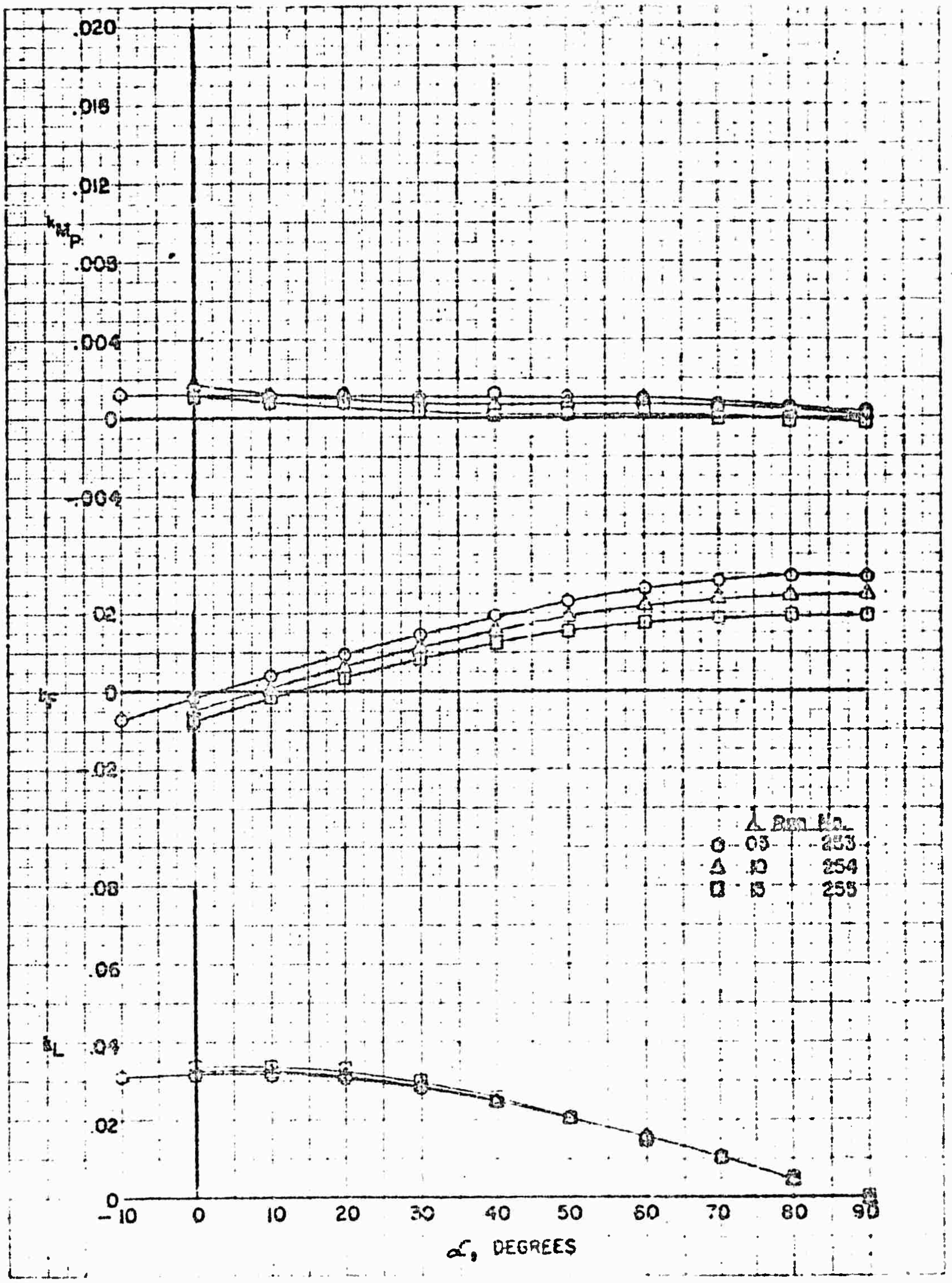

FIGURE 74a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3S\ V_{-10}$

$\beta = 12°$

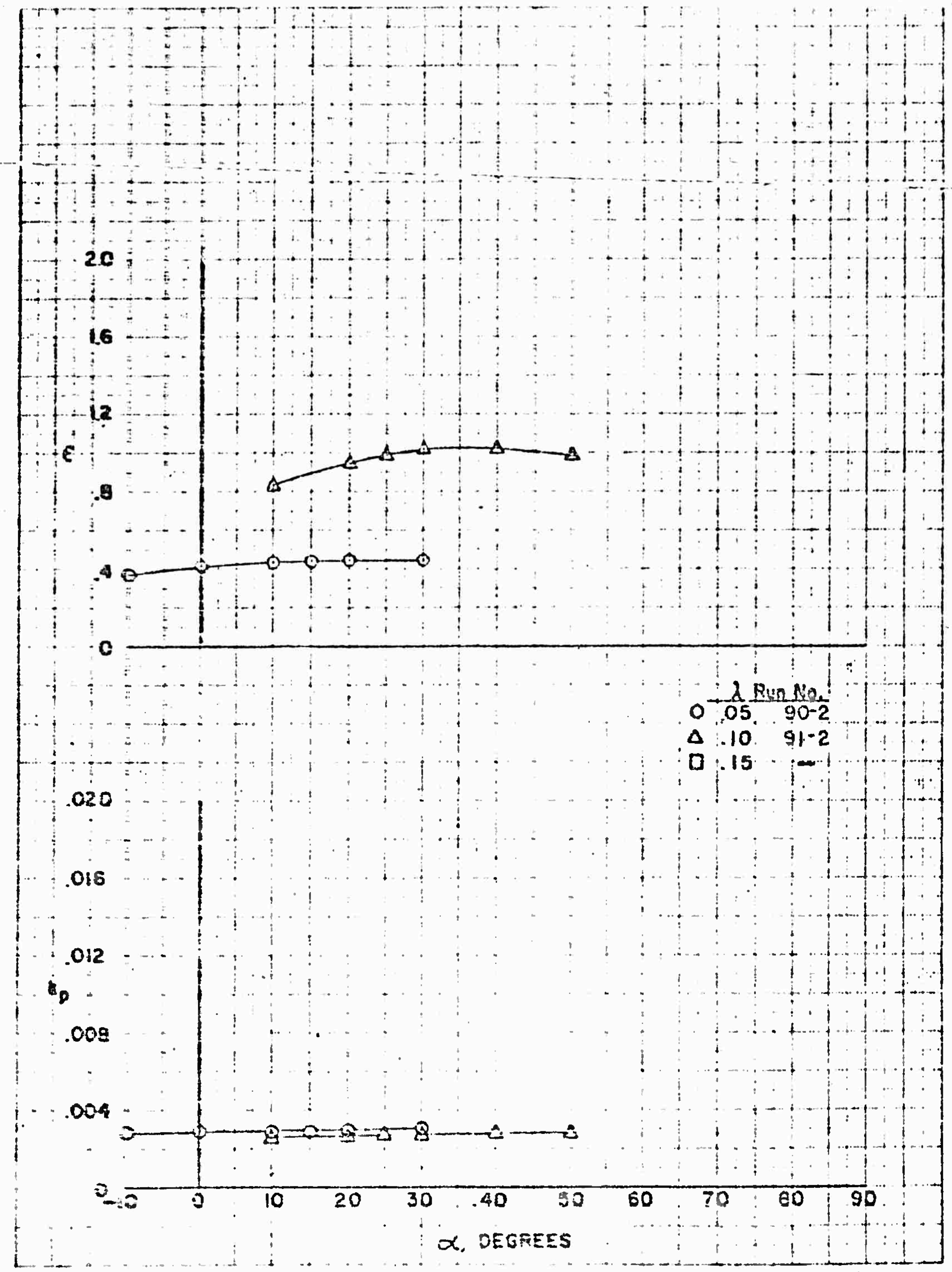

FIGURE 74b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P_3SV_{-10}$

$\beta = 12°$

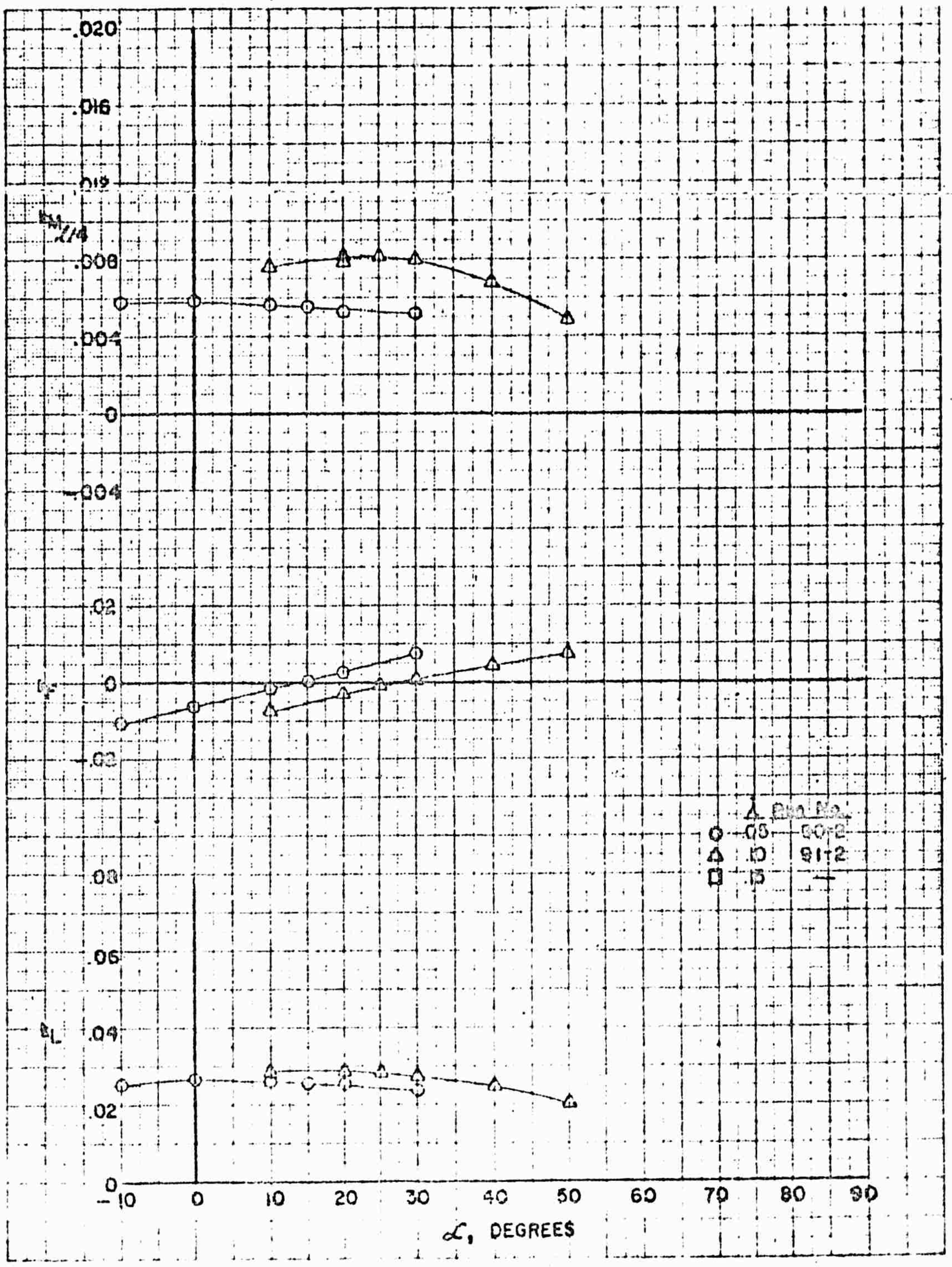

FIGURE 75a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3SV_{-5}$

$\beta = 12°$

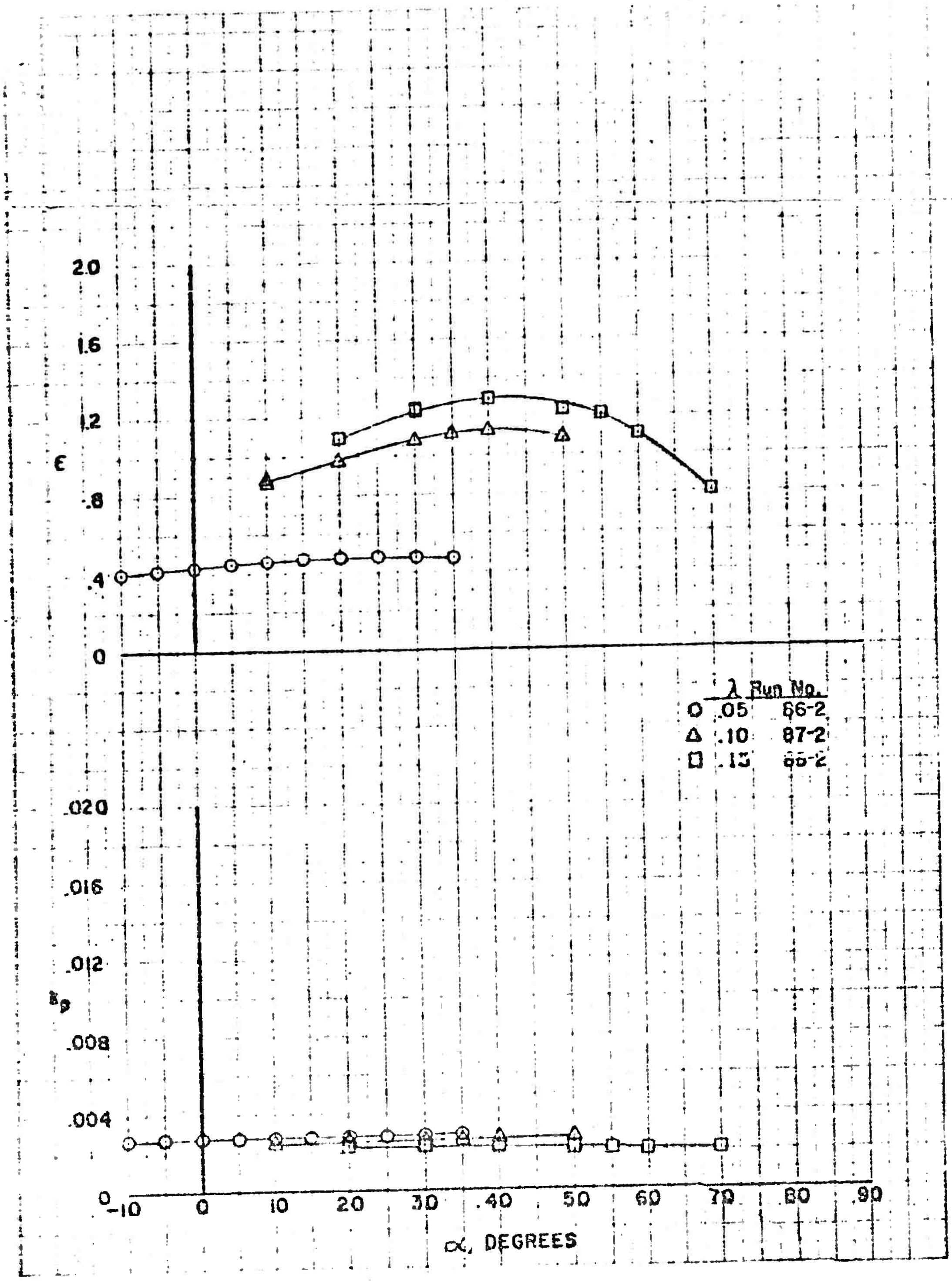

FIGURE 75b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P_3SV_{-5}$

$\beta = 12°$

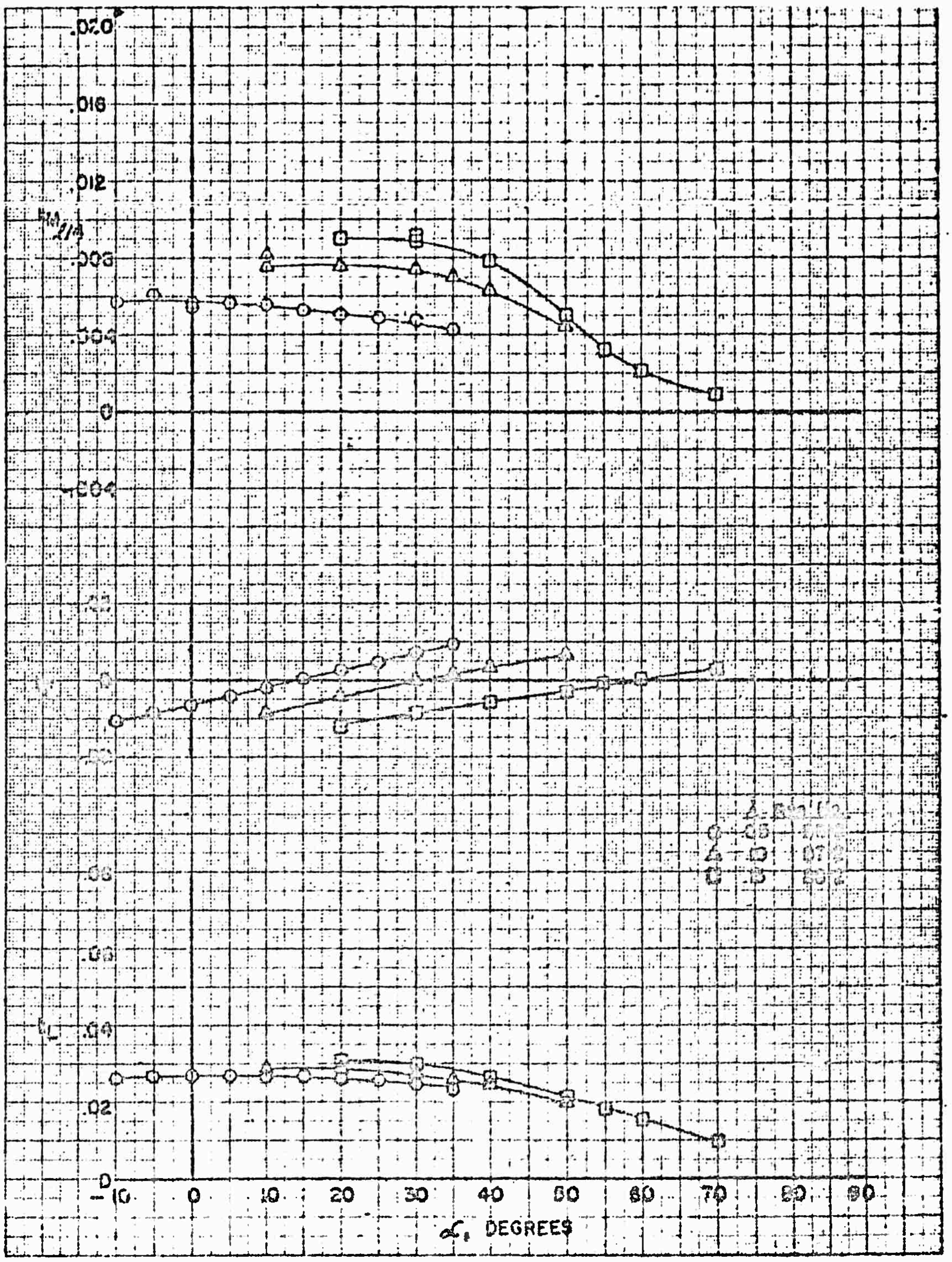

FIGURE 76a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3SV_0$

$\beta = 12°$

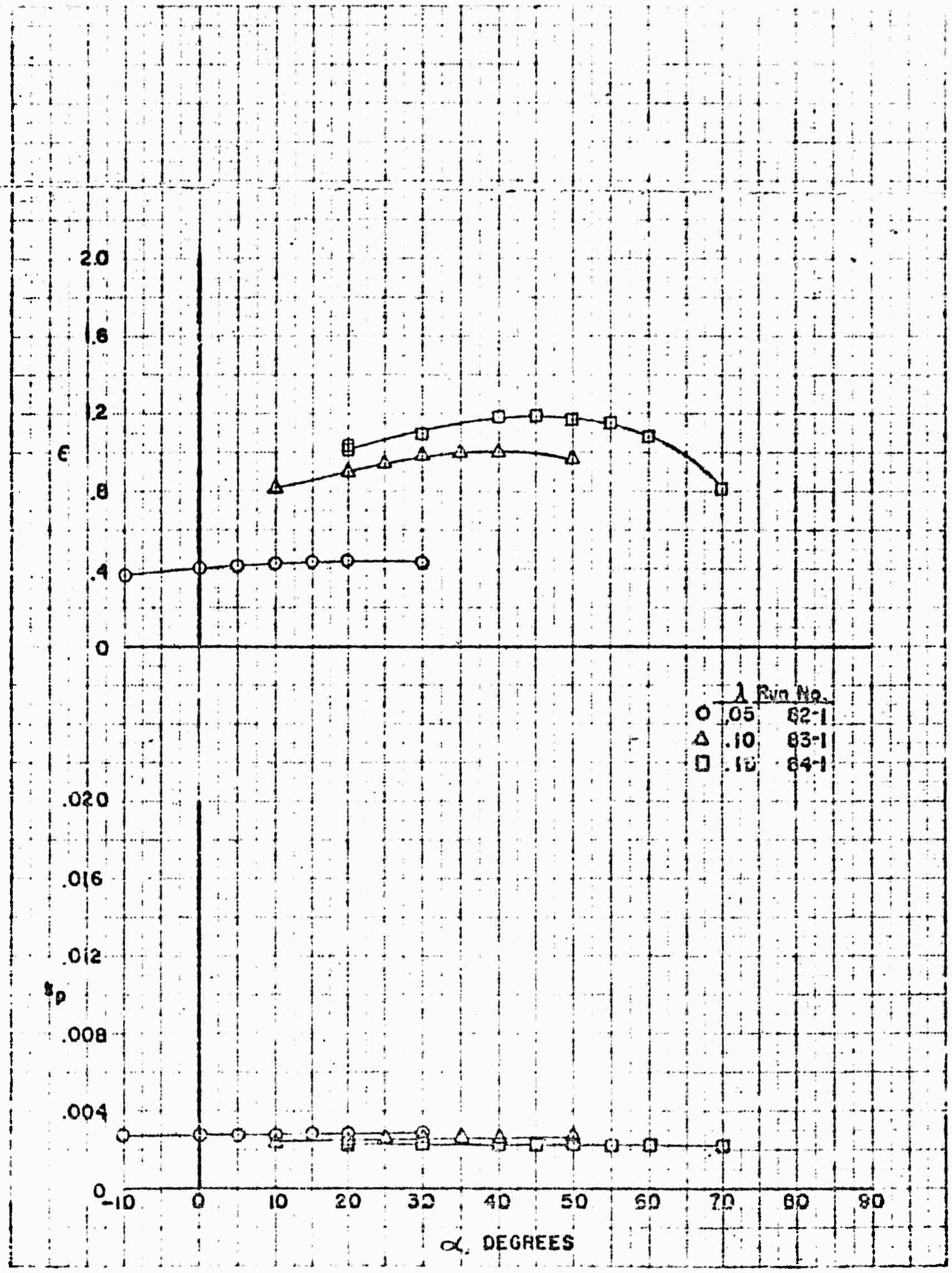

FIGURE 76b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr. 1357 (00) Phase IV

Configuration $D_3P_3SV_0$

$\beta = 12°$

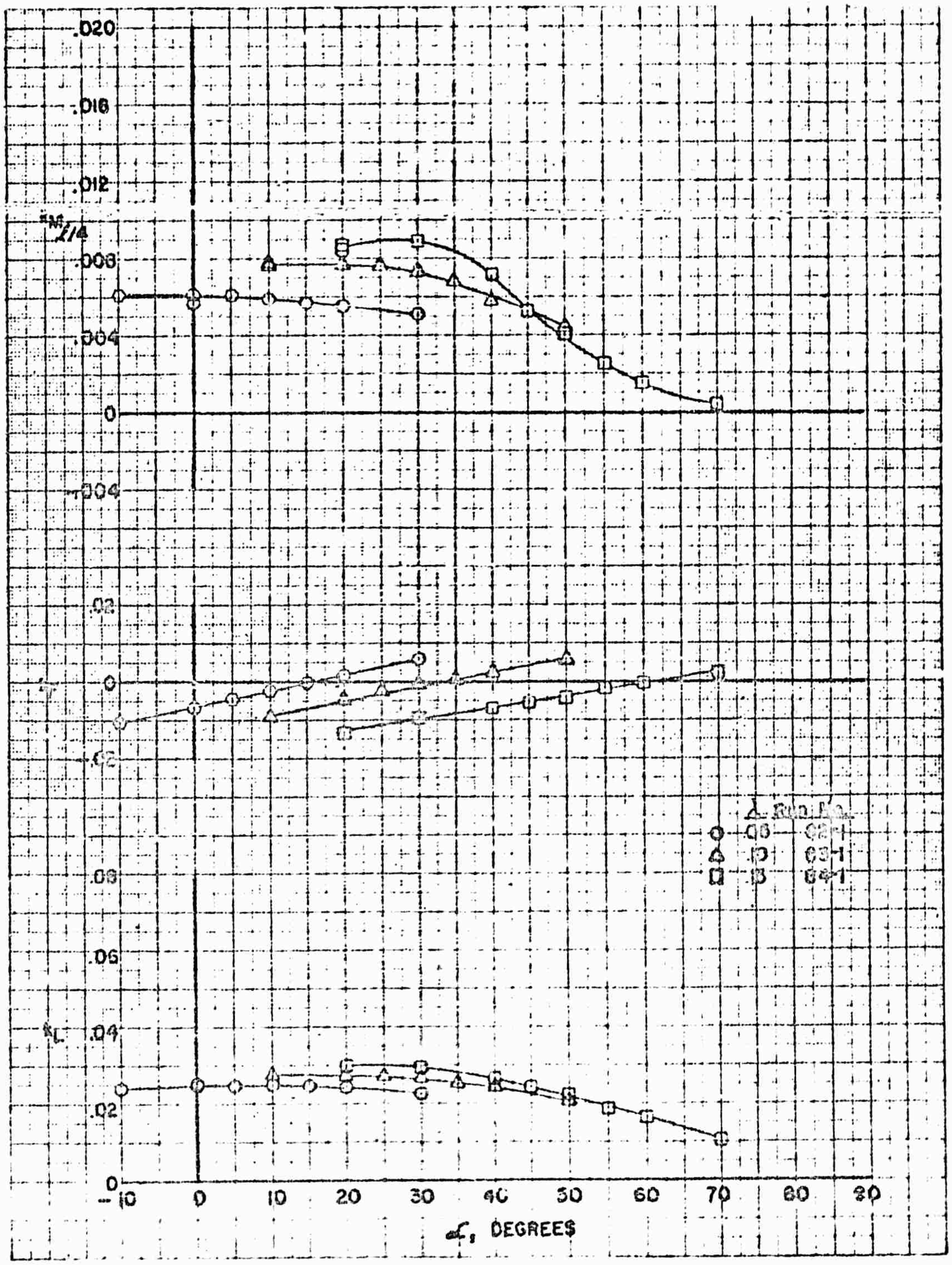

FIGURE 77a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Control Number 1357 (00) Phase IV

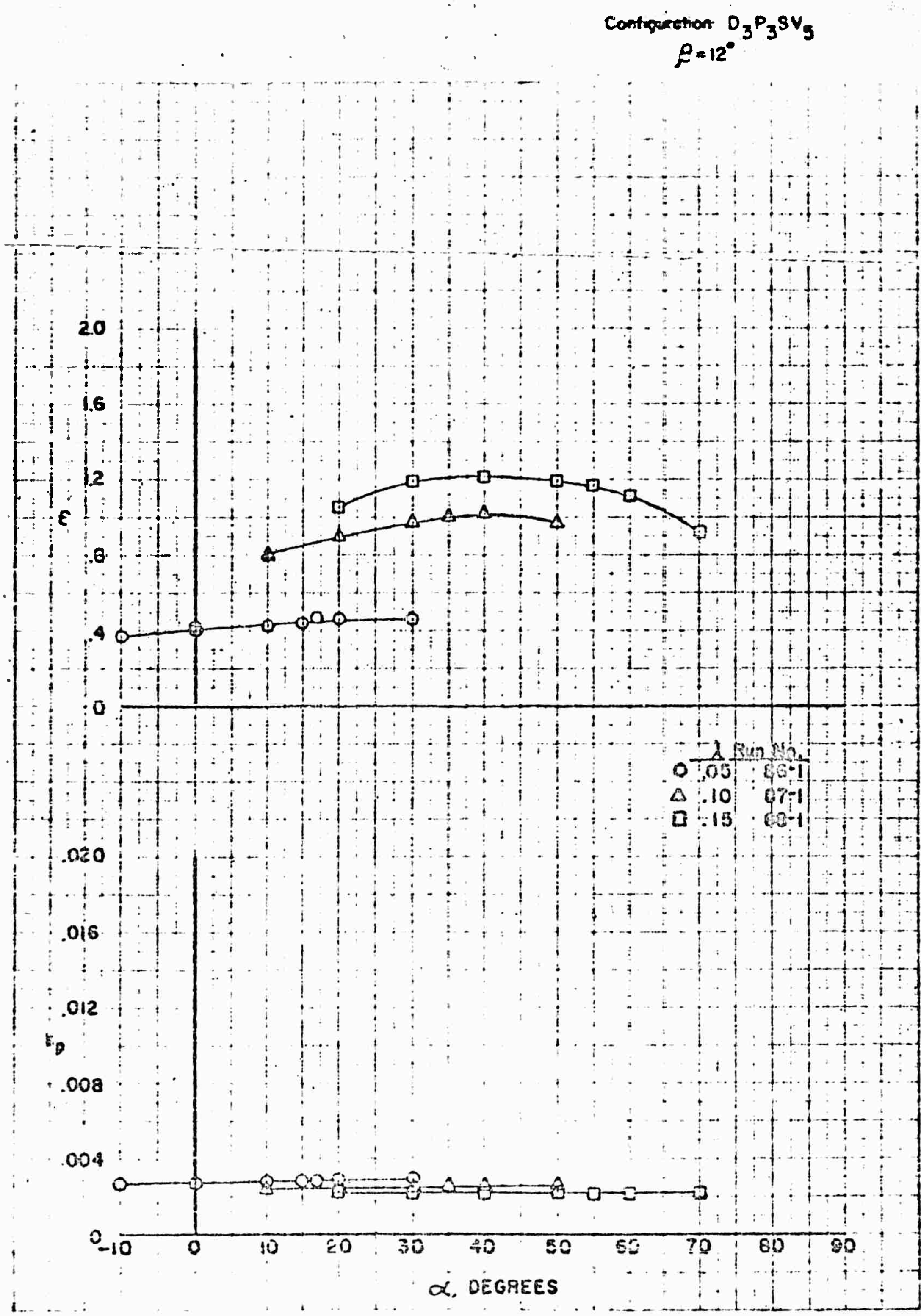

FIGURE 77b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3SV_5$

$\beta = 12°$

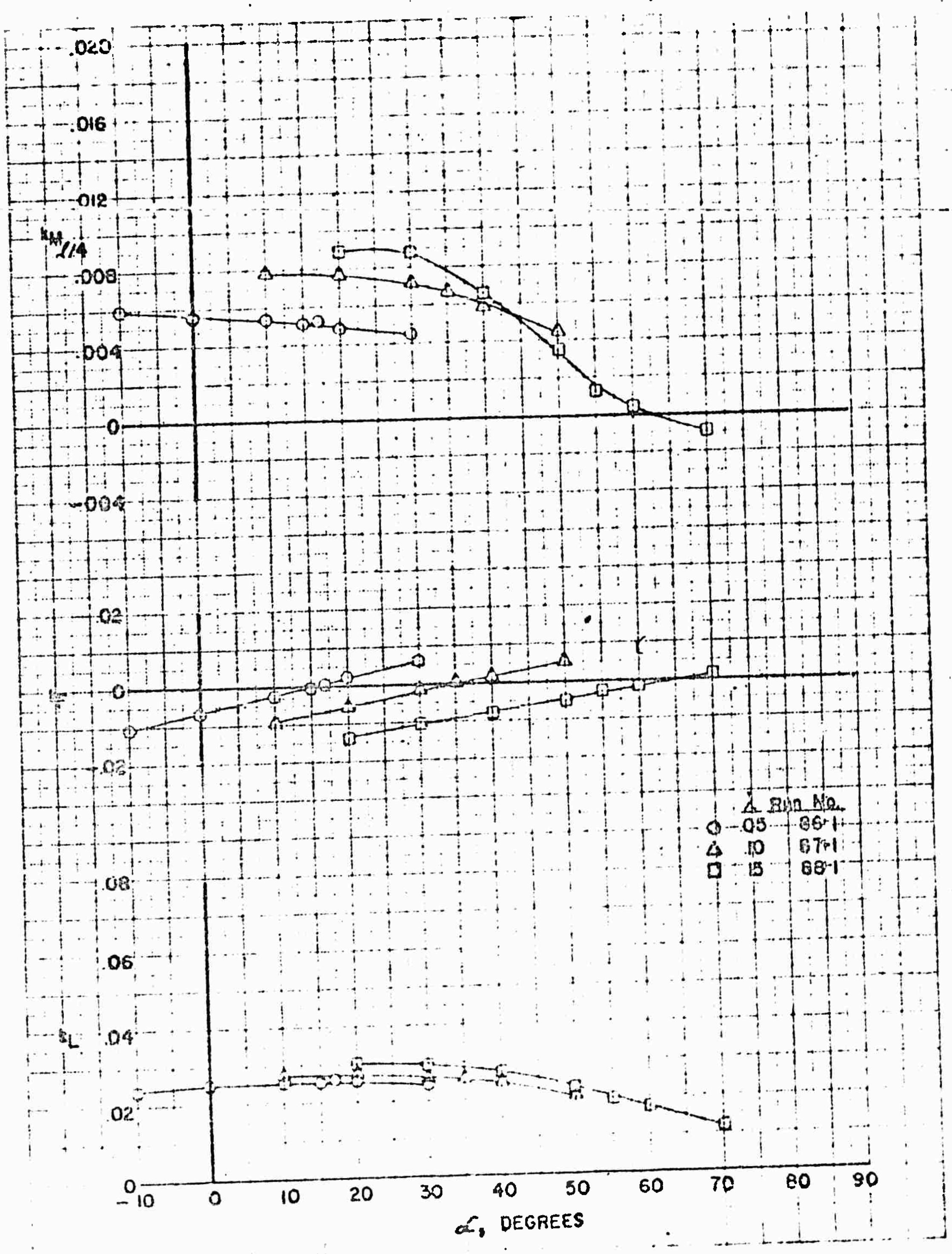

FIGURE 78a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3SV_{10}$

$\beta = 12°$

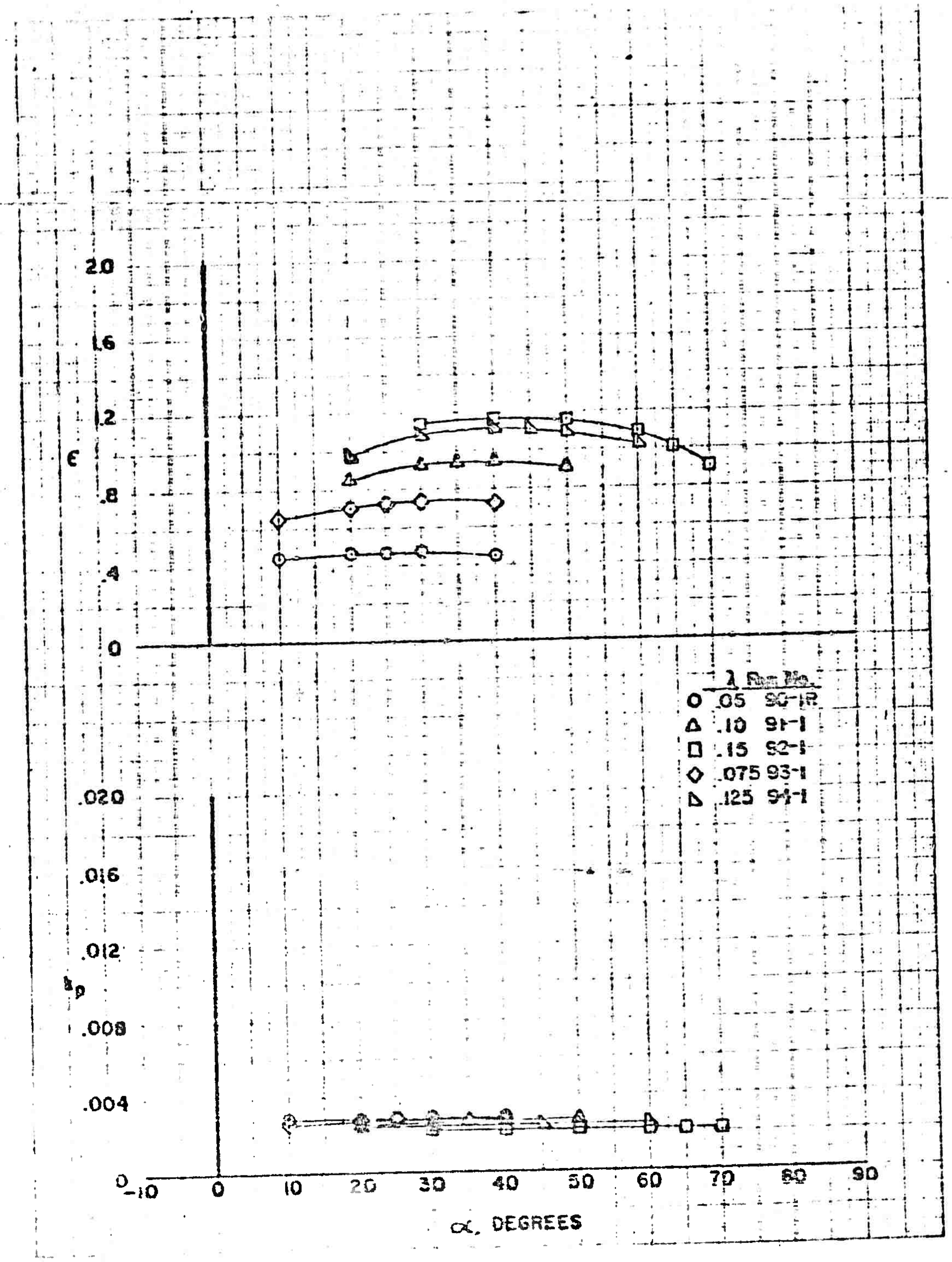

FIGURE 78b. VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P_3SV_{10}$

$\beta = 12°$

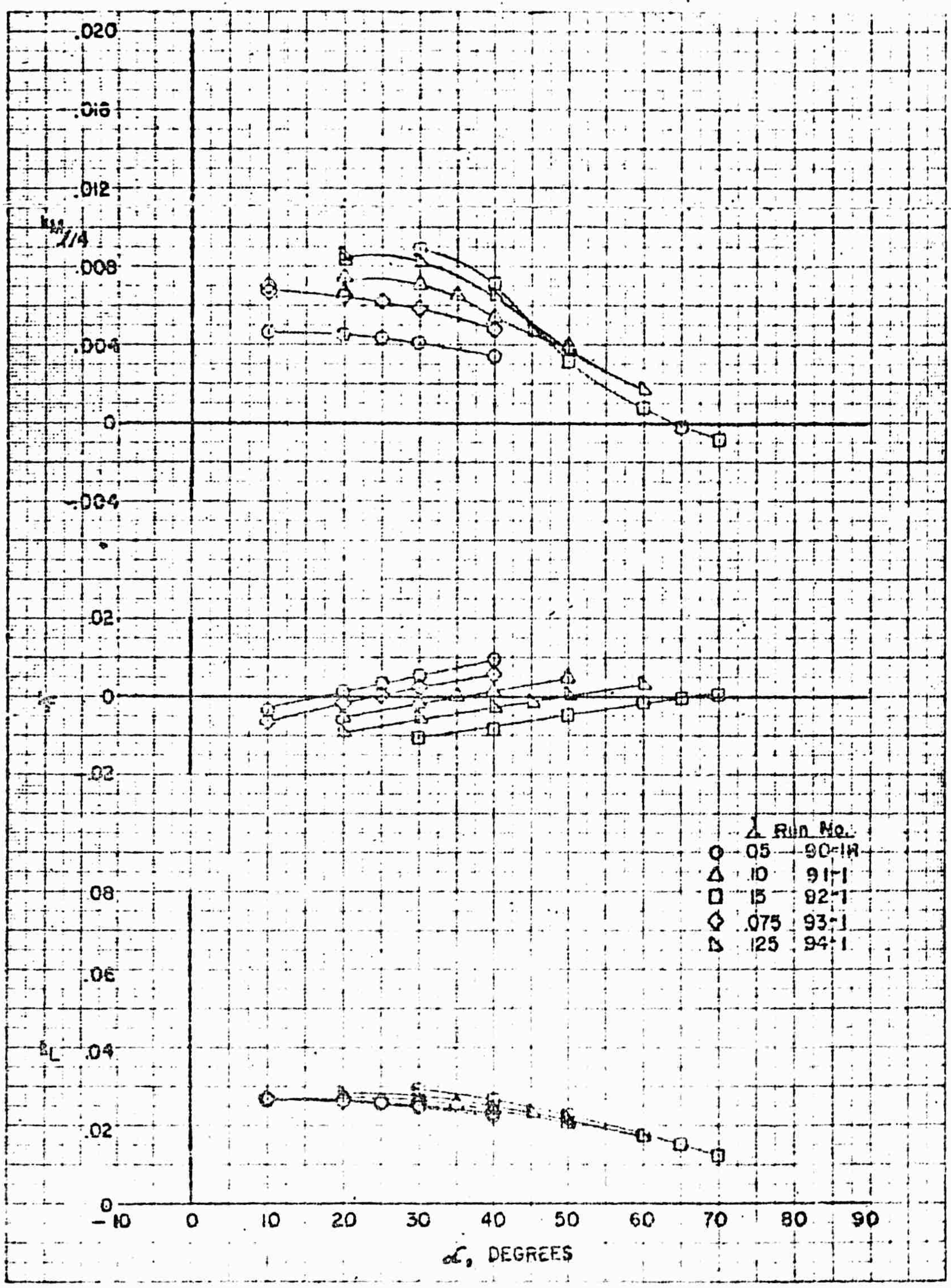

FIGURE 79a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr -1357 (00) Phase IV

Configuration $D_3P_3SV_{15}$

$\beta = 12°$

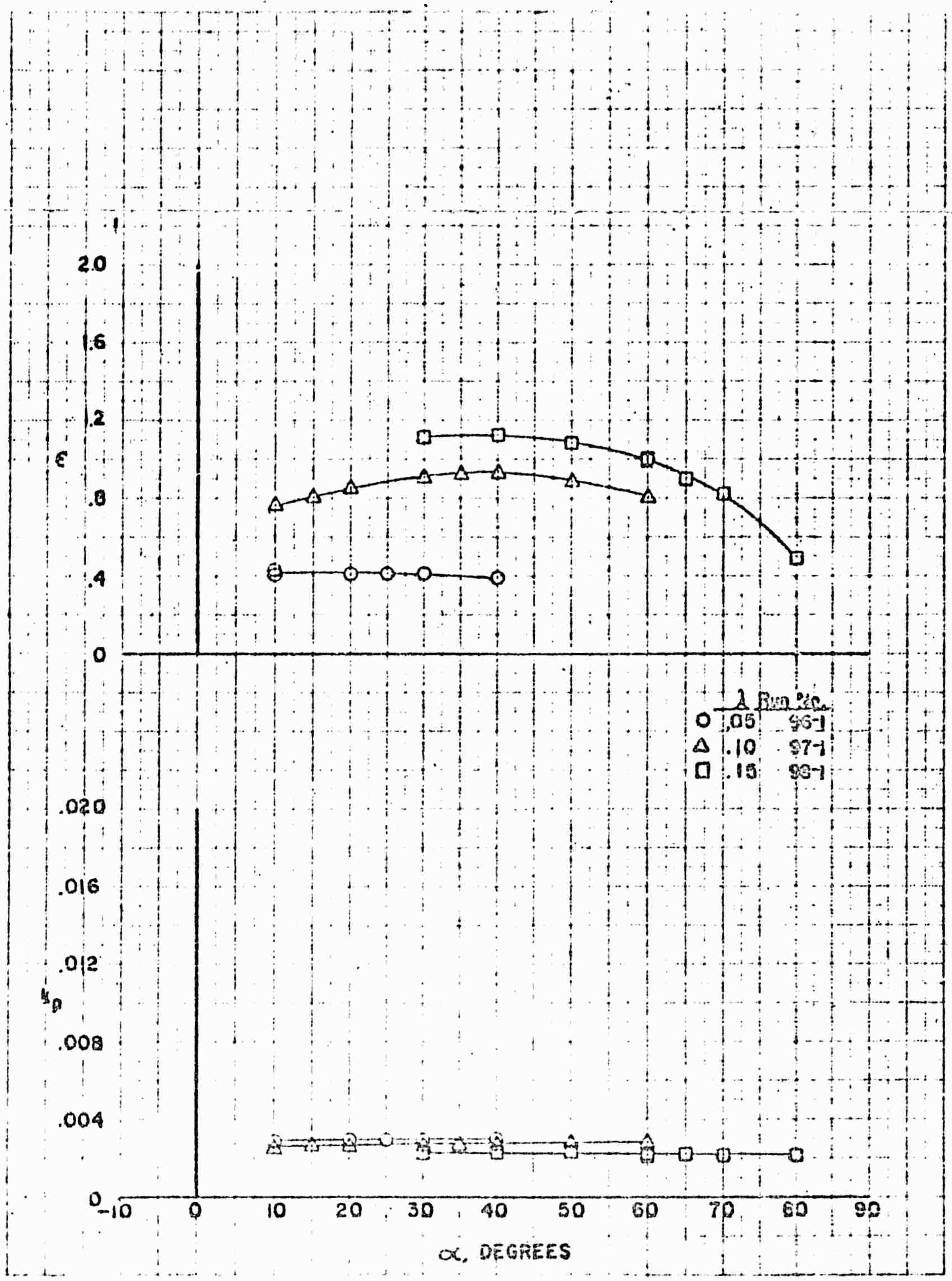

FIGURE 79b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P_3SV_{15}$

$\beta = 12°$

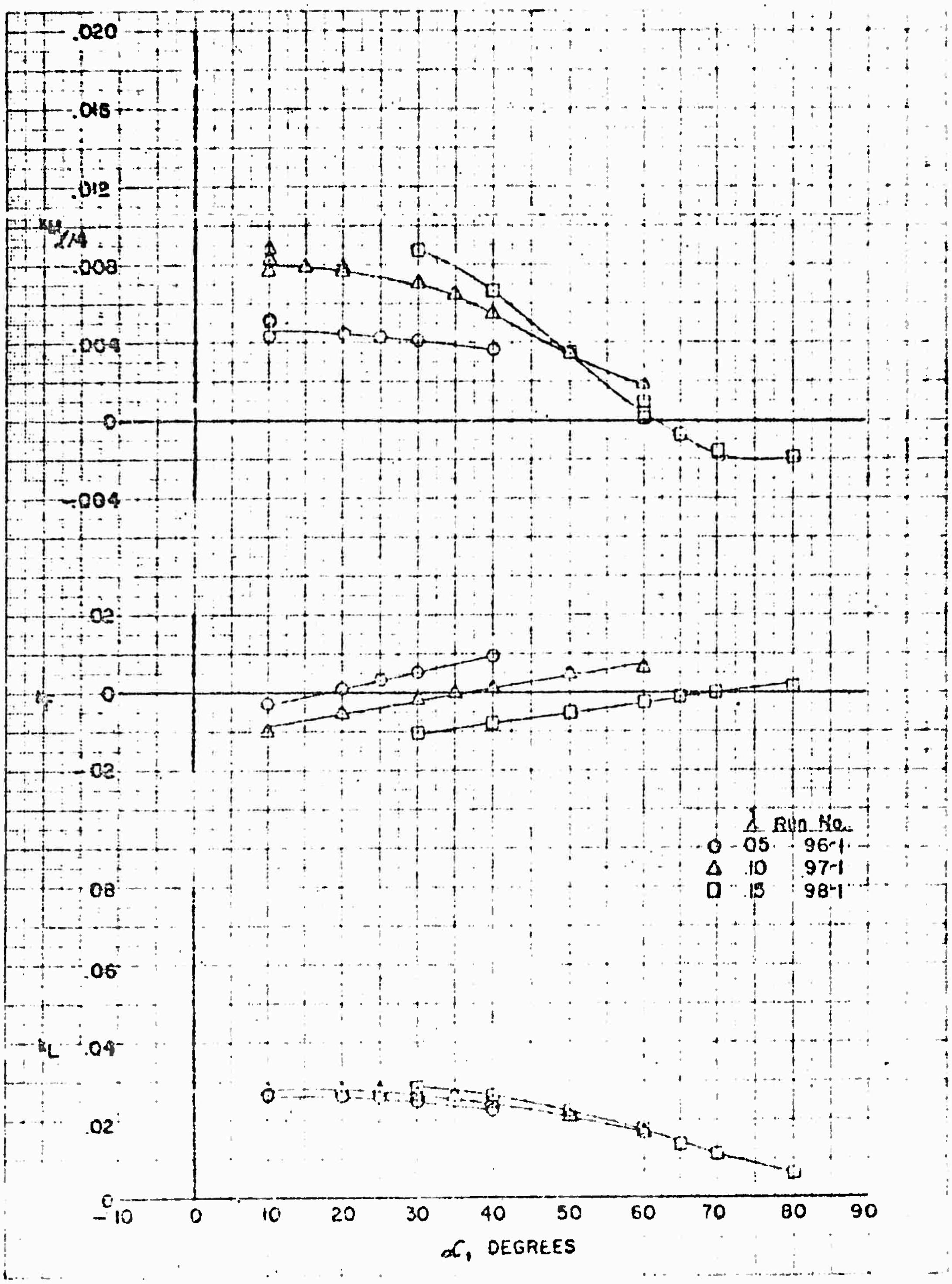

FIGURE 80a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_2SV_0$

$\beta = 18°$

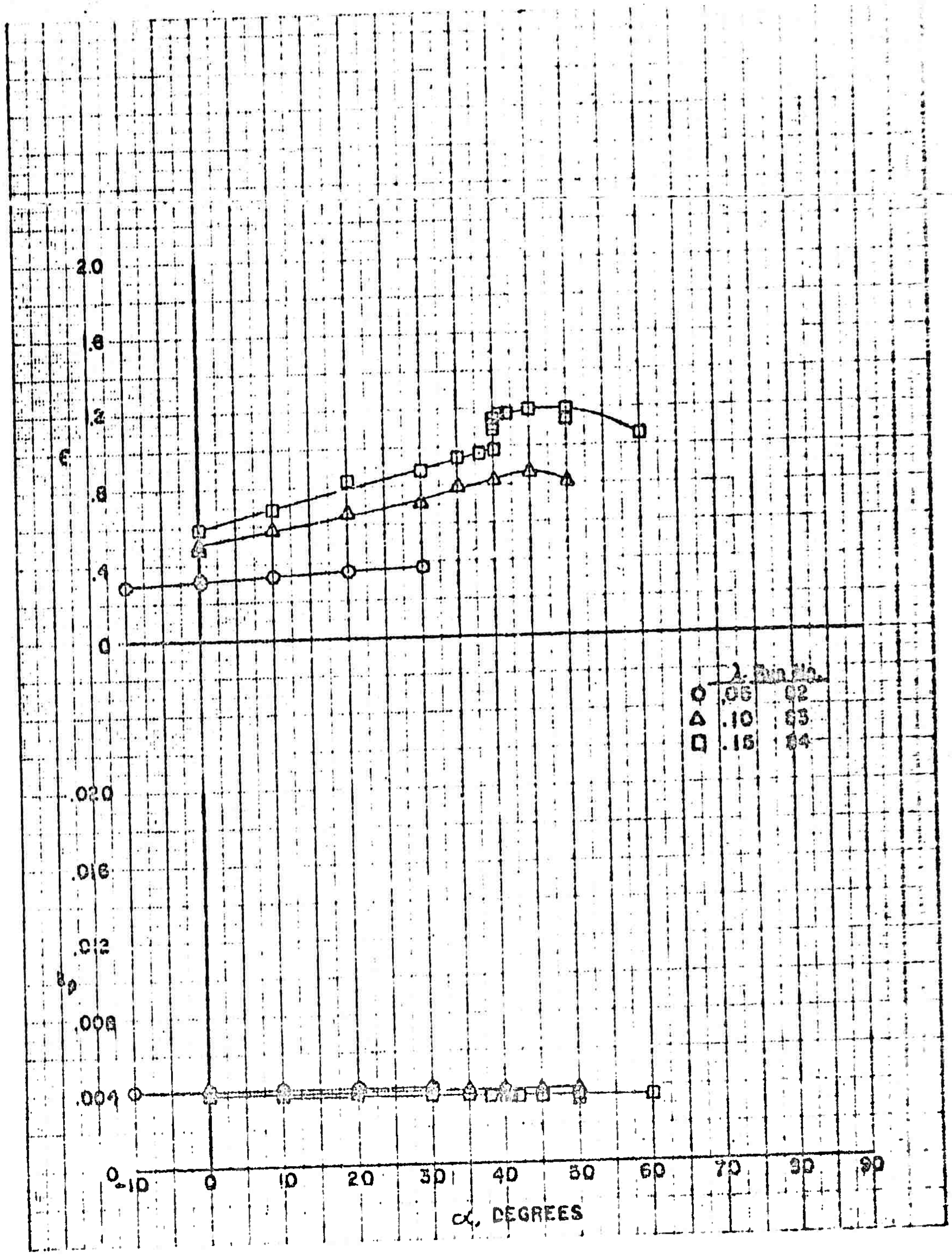

FIGURE 80b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_2SV_0$

$\beta = 18°$

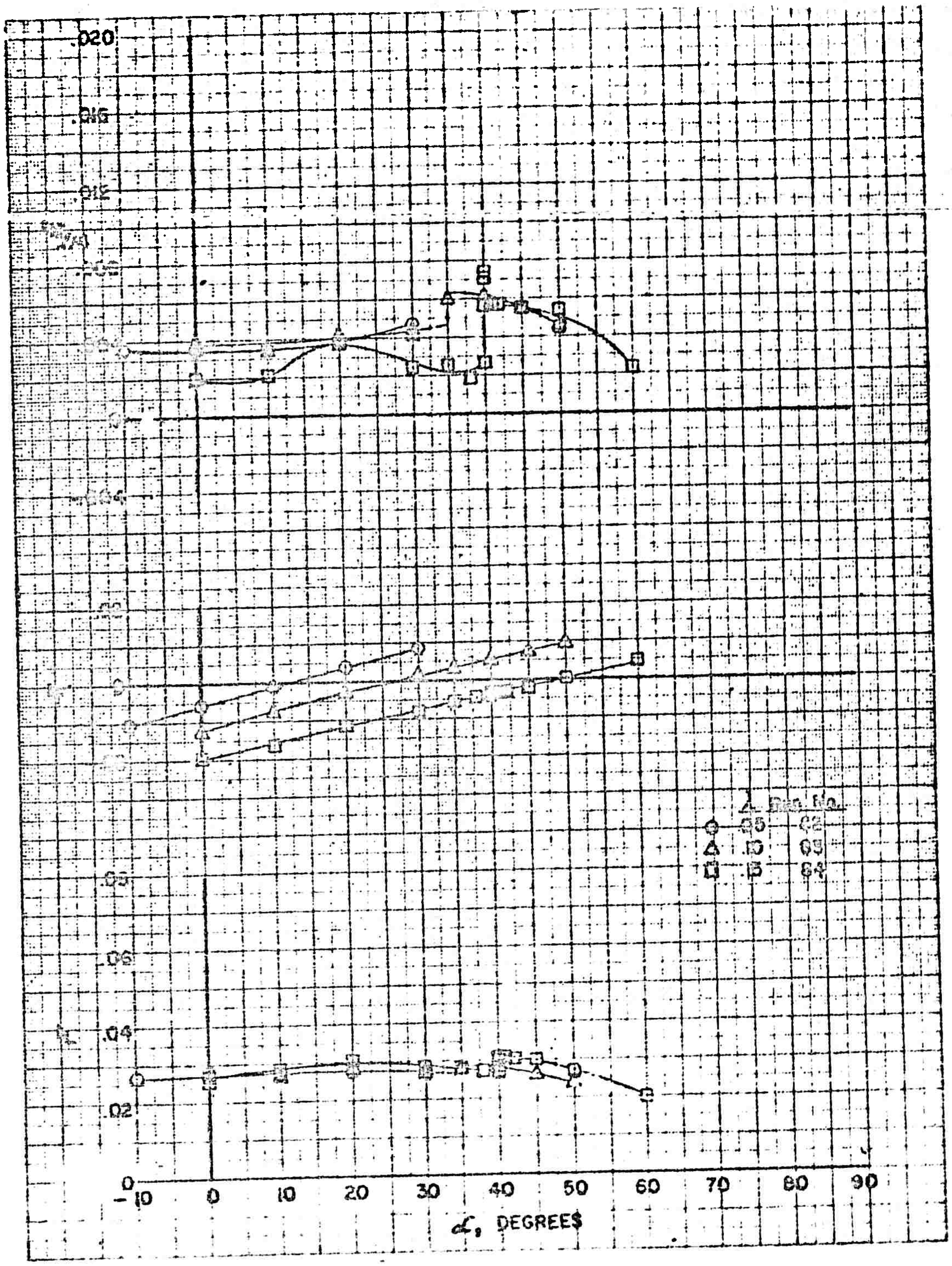

FIGURE 81a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3H

$\beta = 5°$

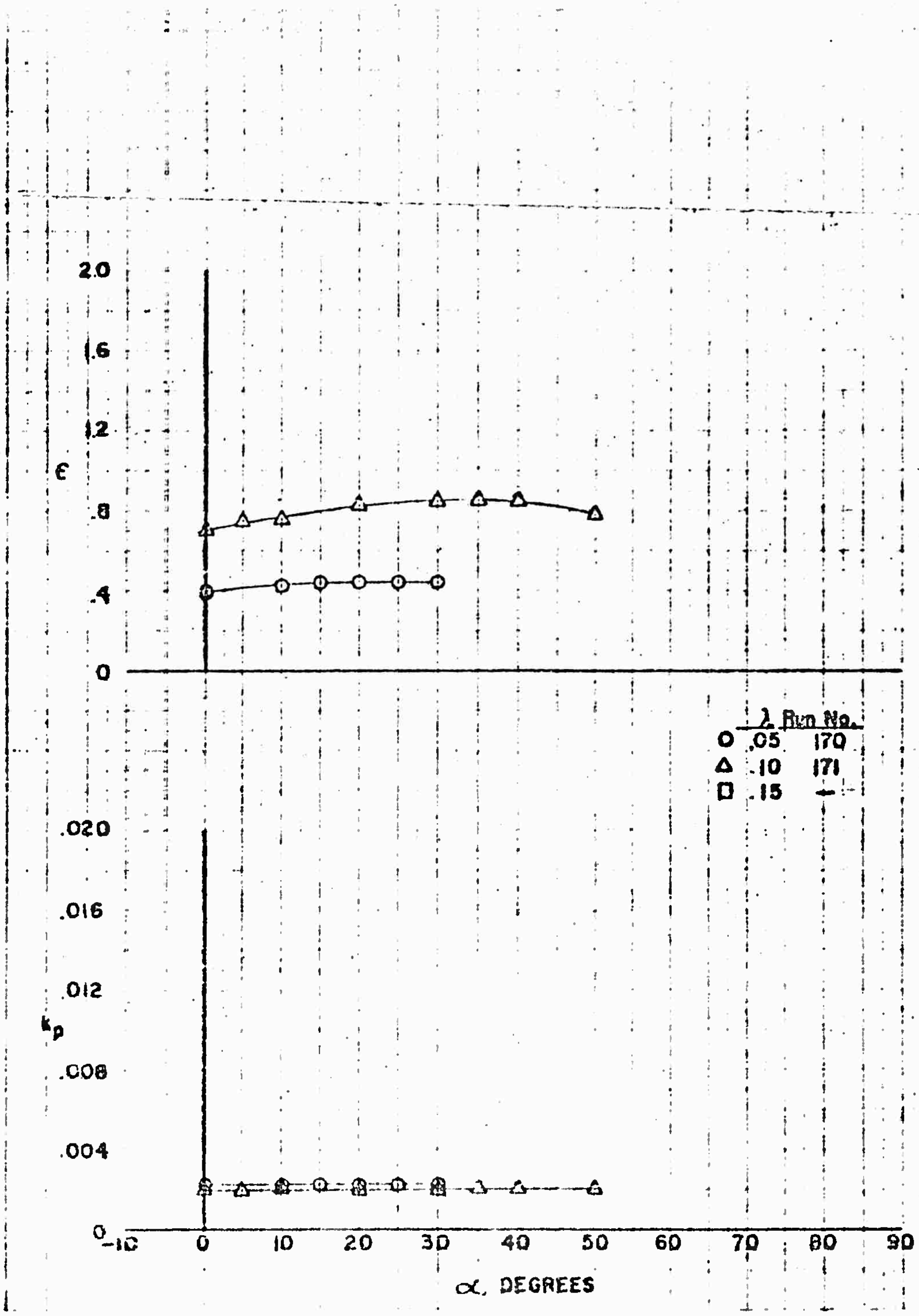

FIGURE 81b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3H

$\beta = 9°$

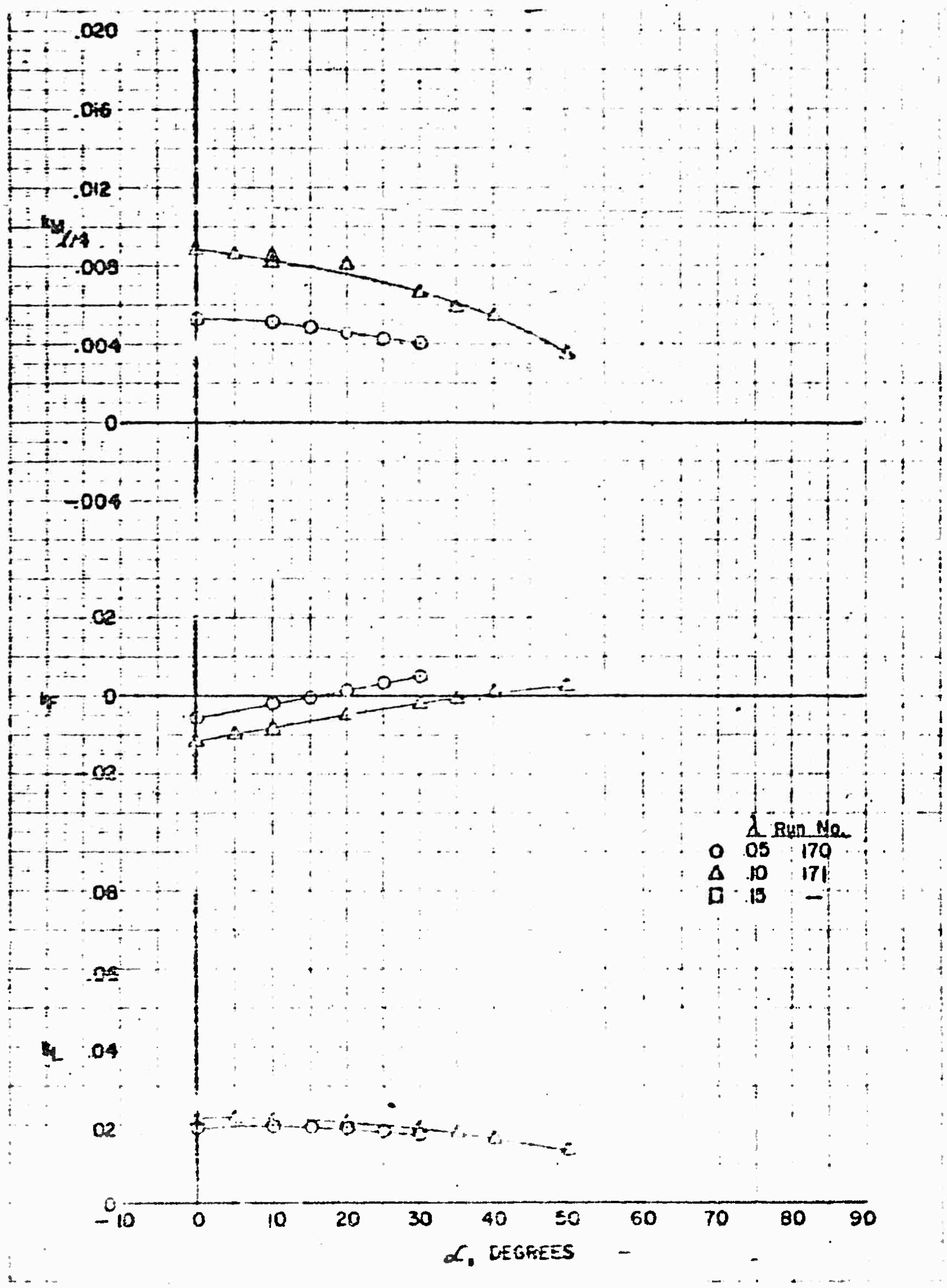

FIGURE 82a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3 P_3 H$

$\beta = 12°$

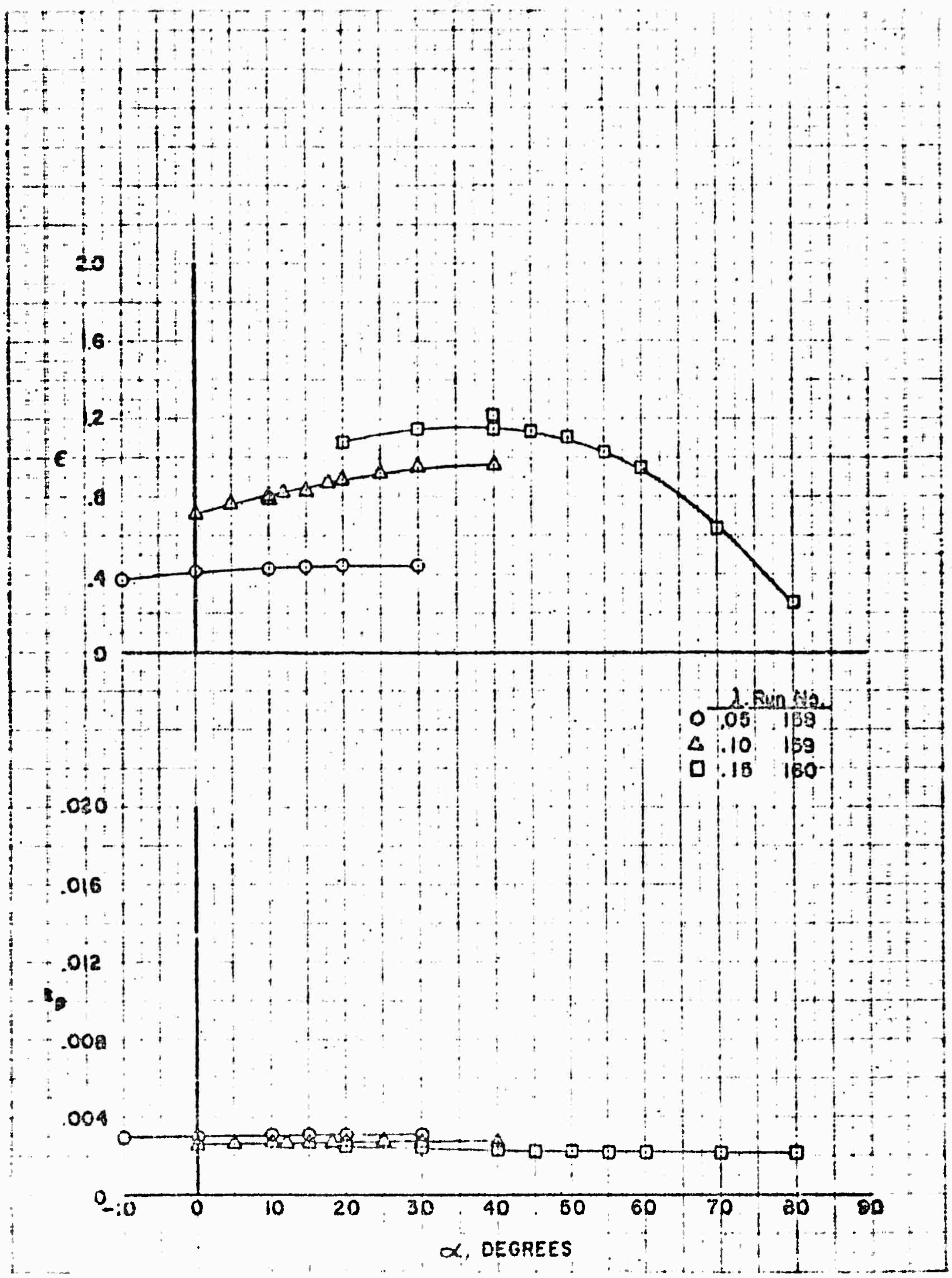

FIGURE 82b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3H

$\beta = 12°$

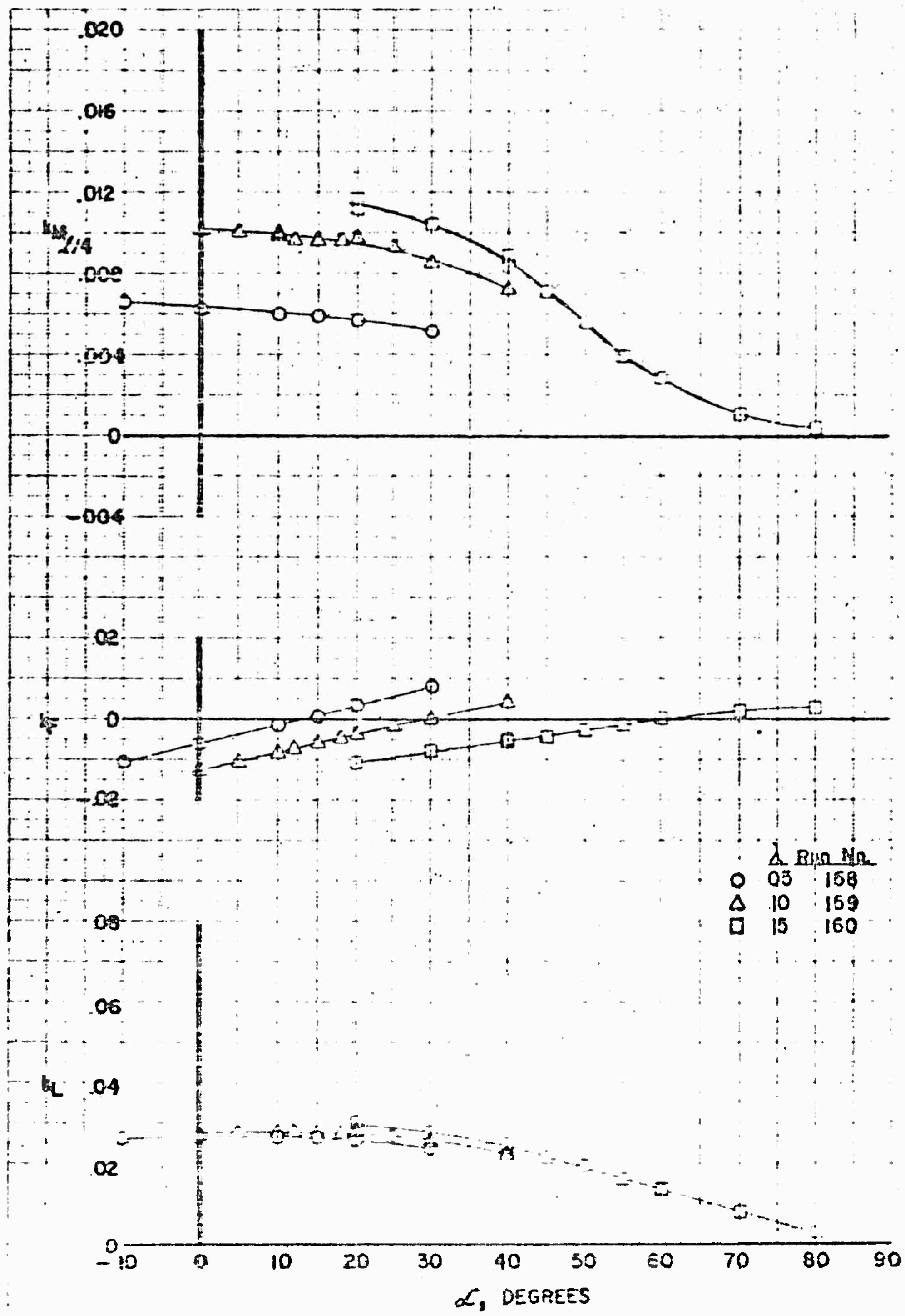

FIGURE 83a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3 P_3 H$

$\beta = 15°$

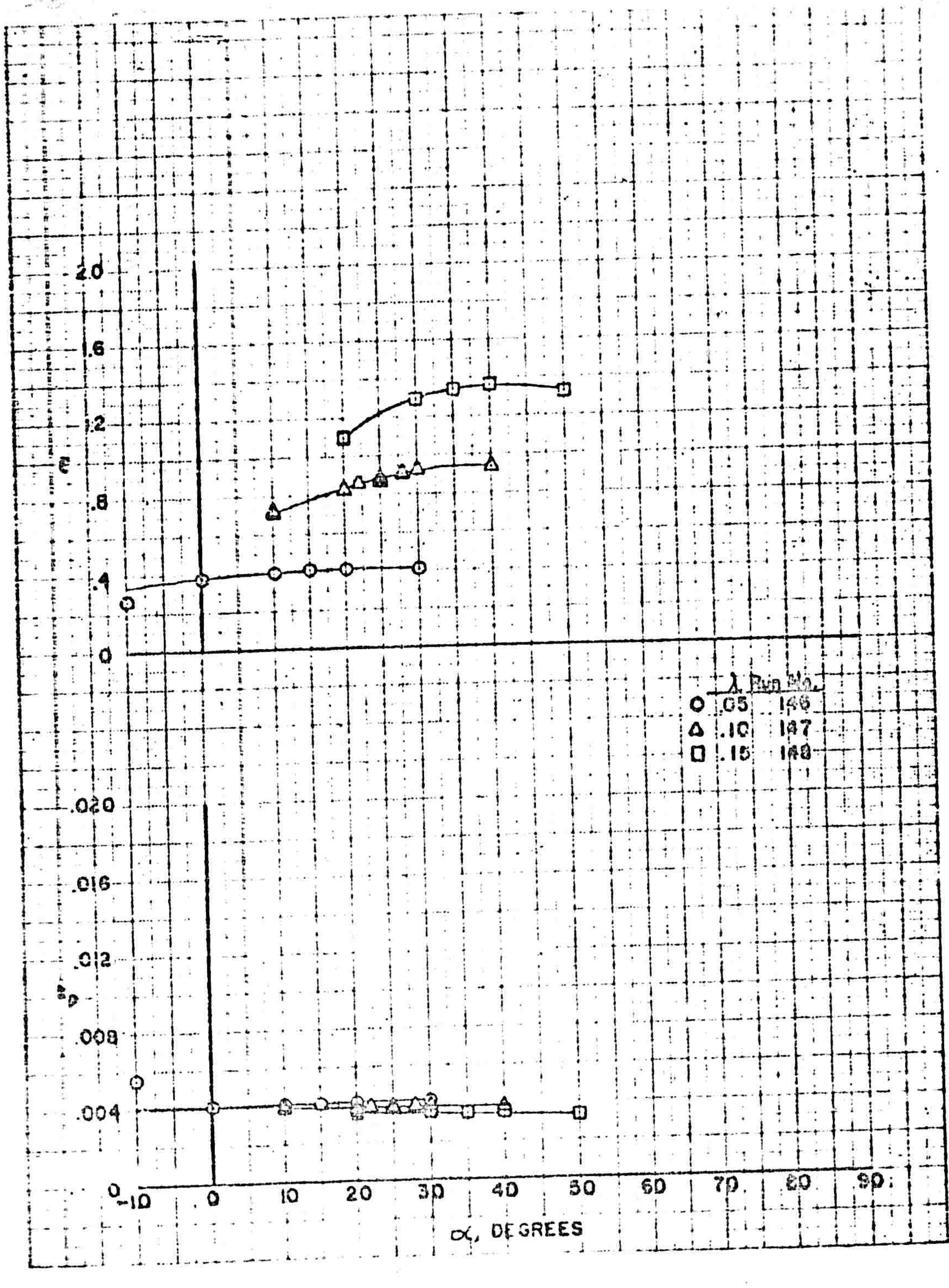

FIGURE 63b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

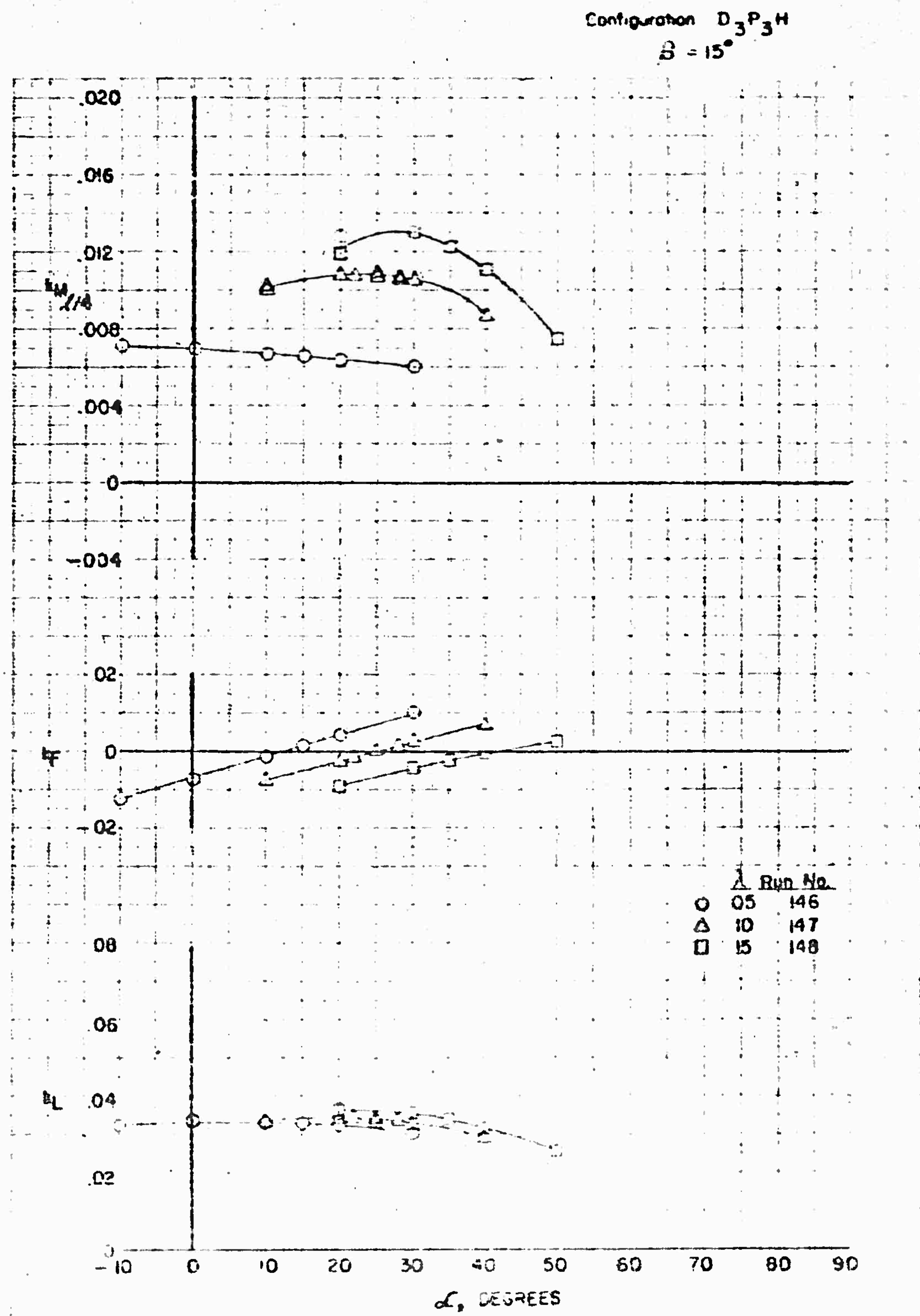

FIGURE 84a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3HB

$\beta = 9°$

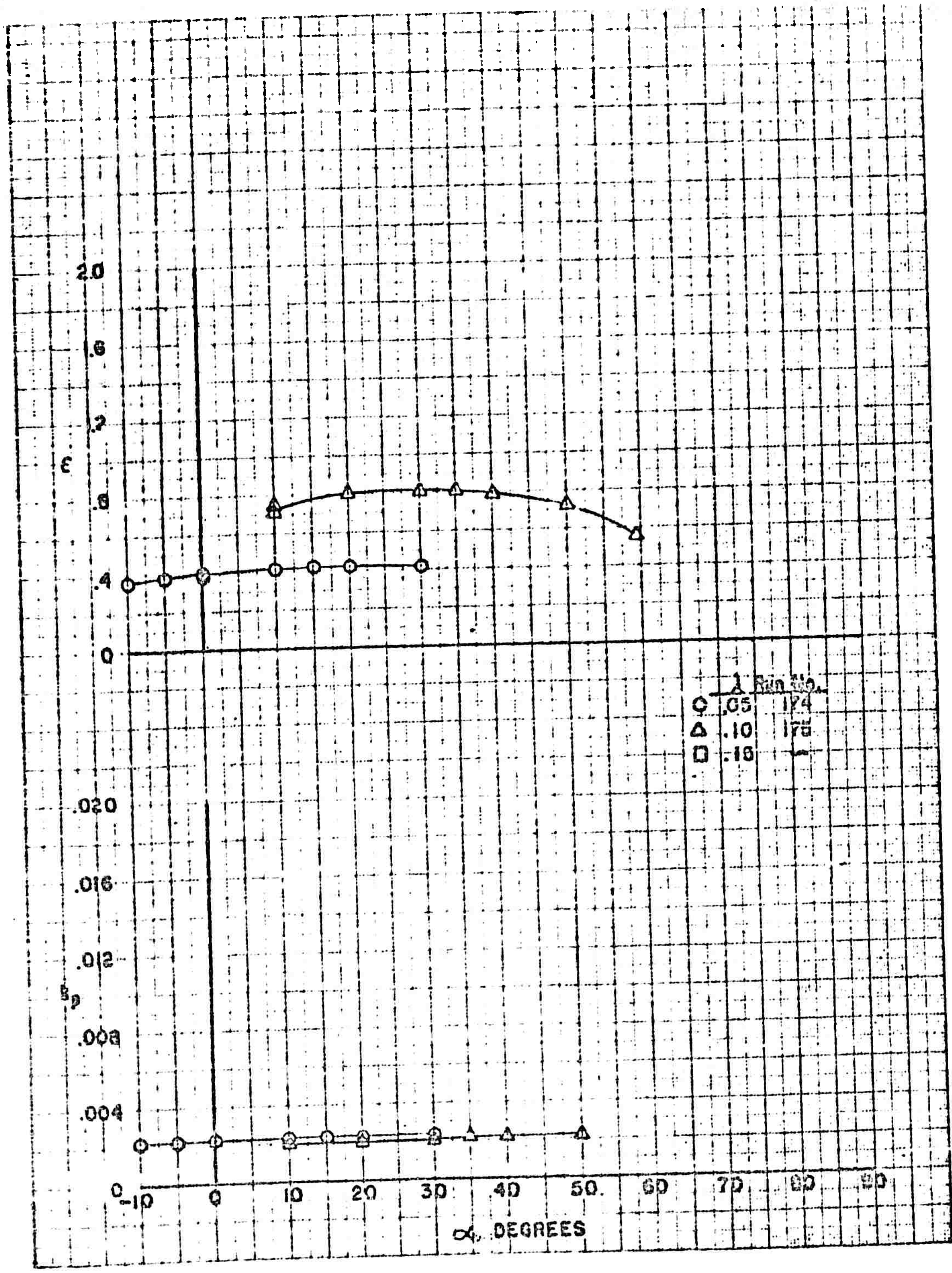

FIGURE 84b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (OC) Phase IV

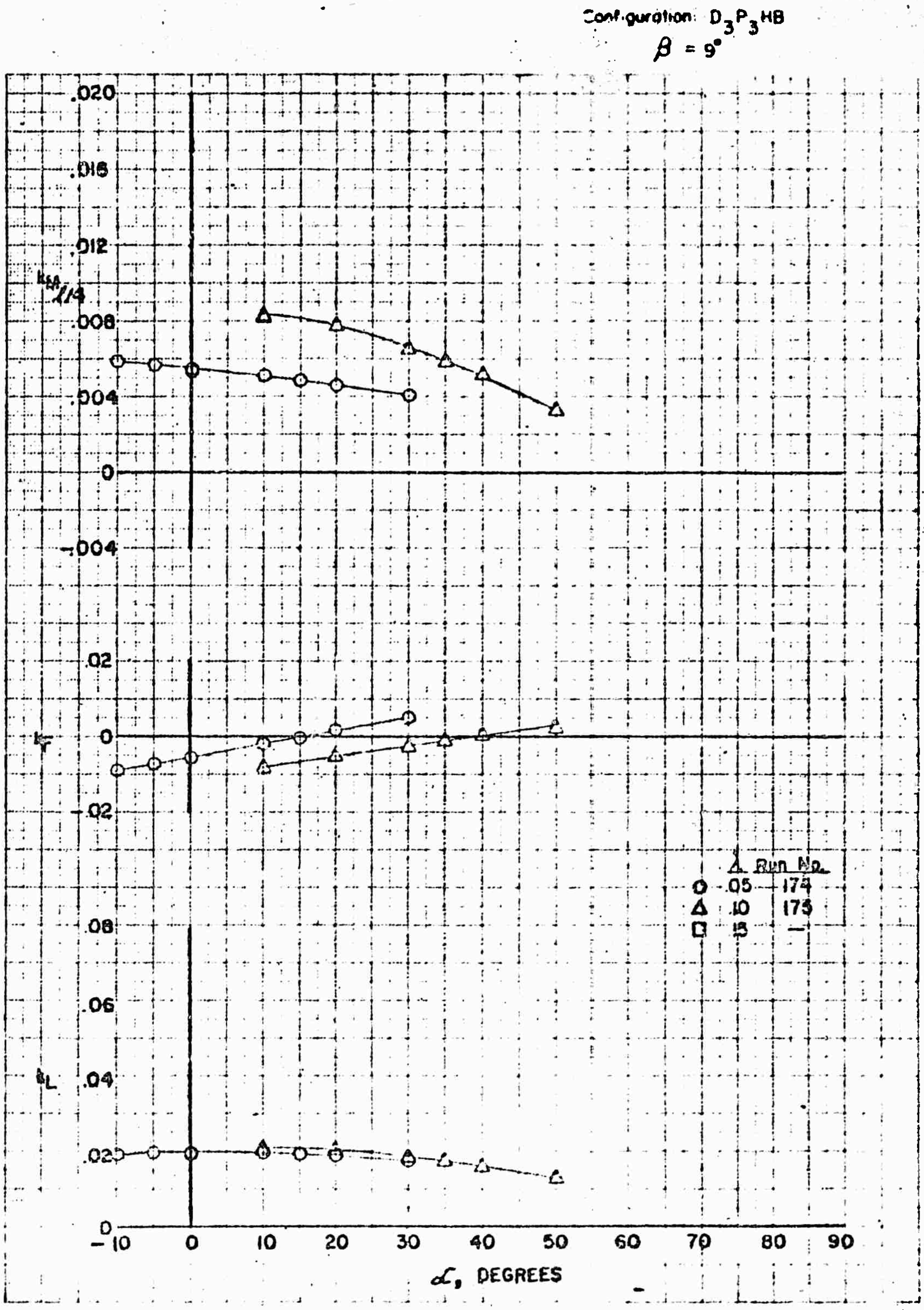

FIGURE 85c VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

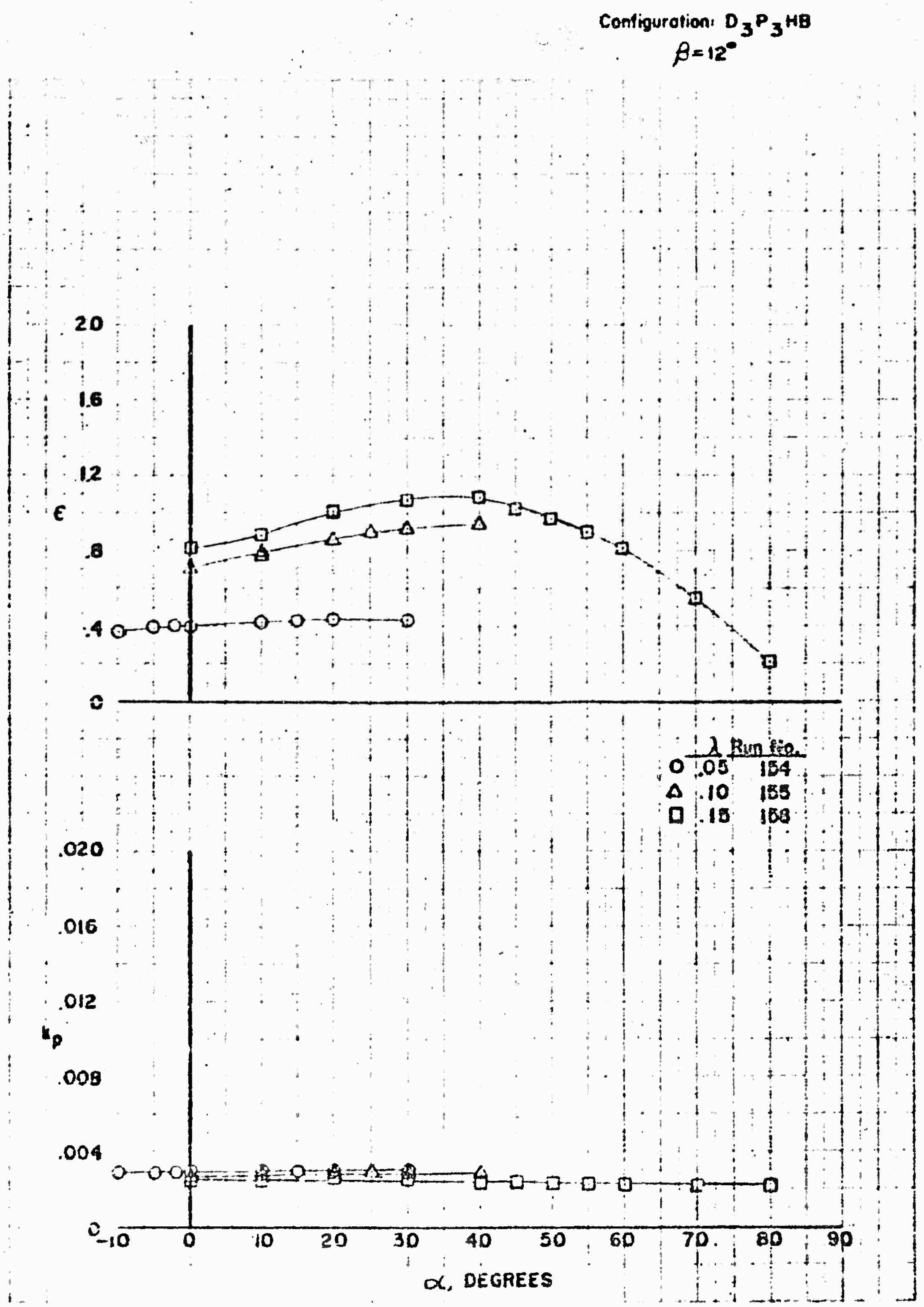

FIGURE 85b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3HB
$\beta = 12°$

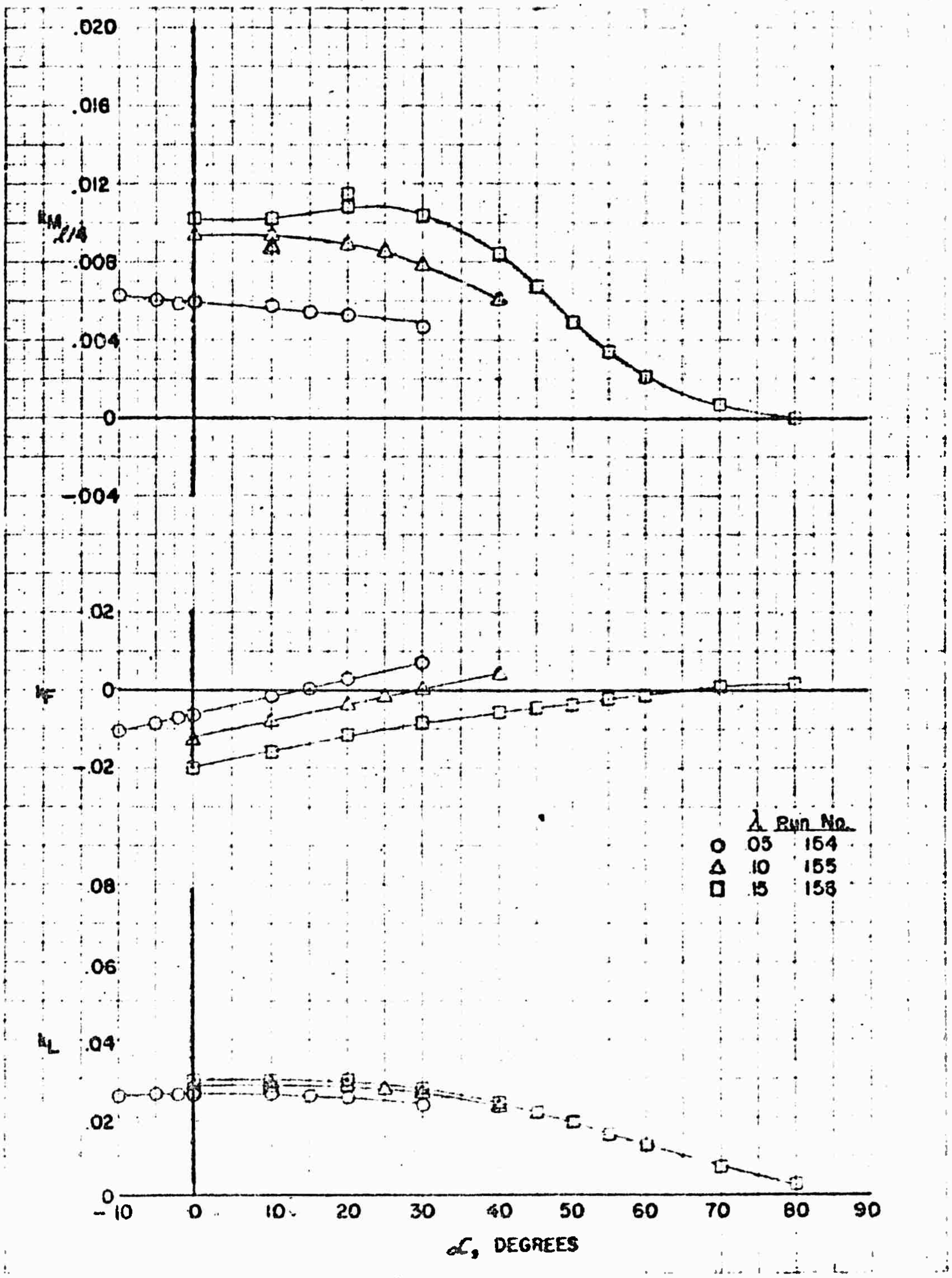

FIGURE 86a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3 P_3$ HB

$\beta = 15°$

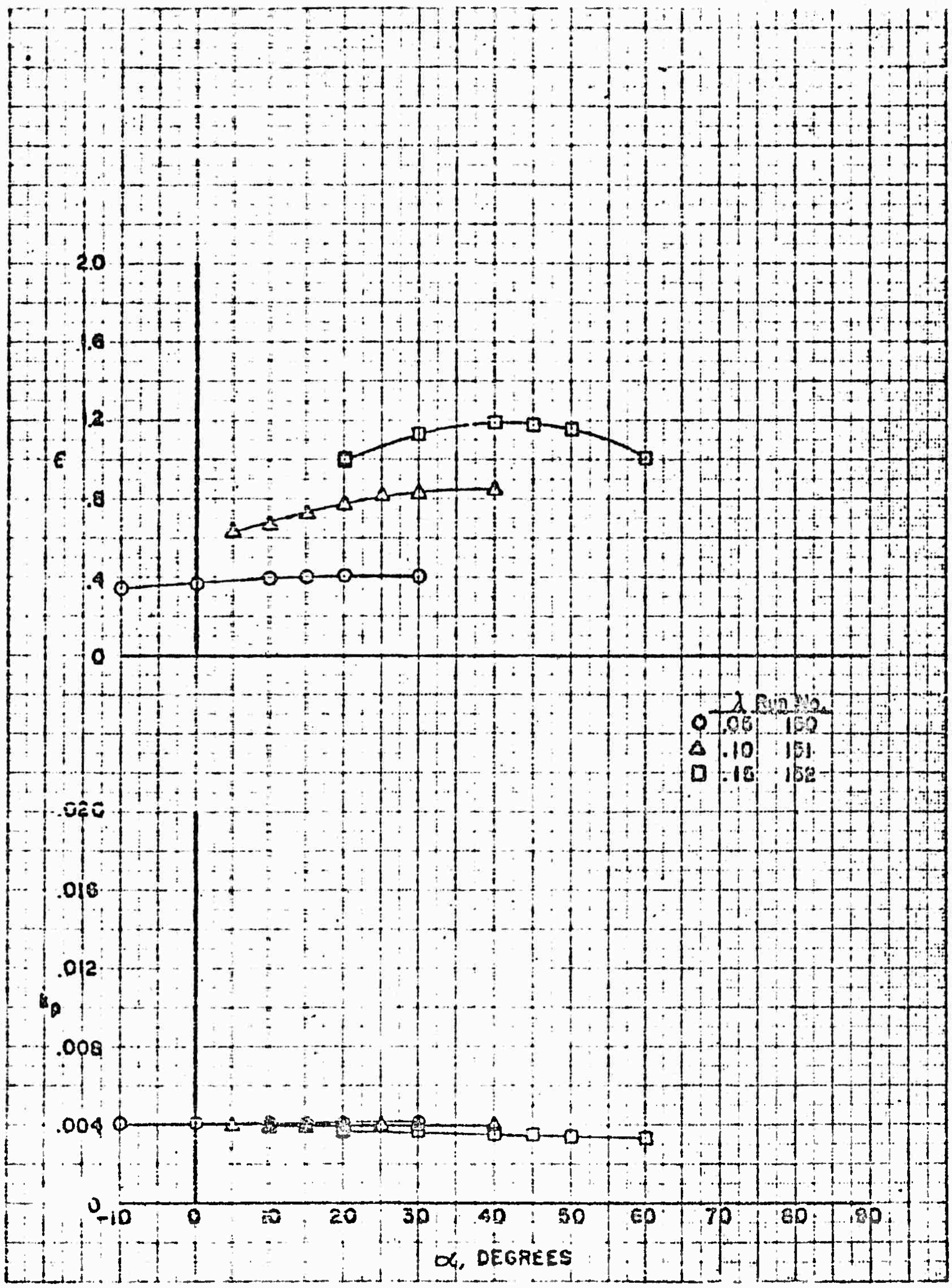

FIGURE 86b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3HB

$\beta = 15°$

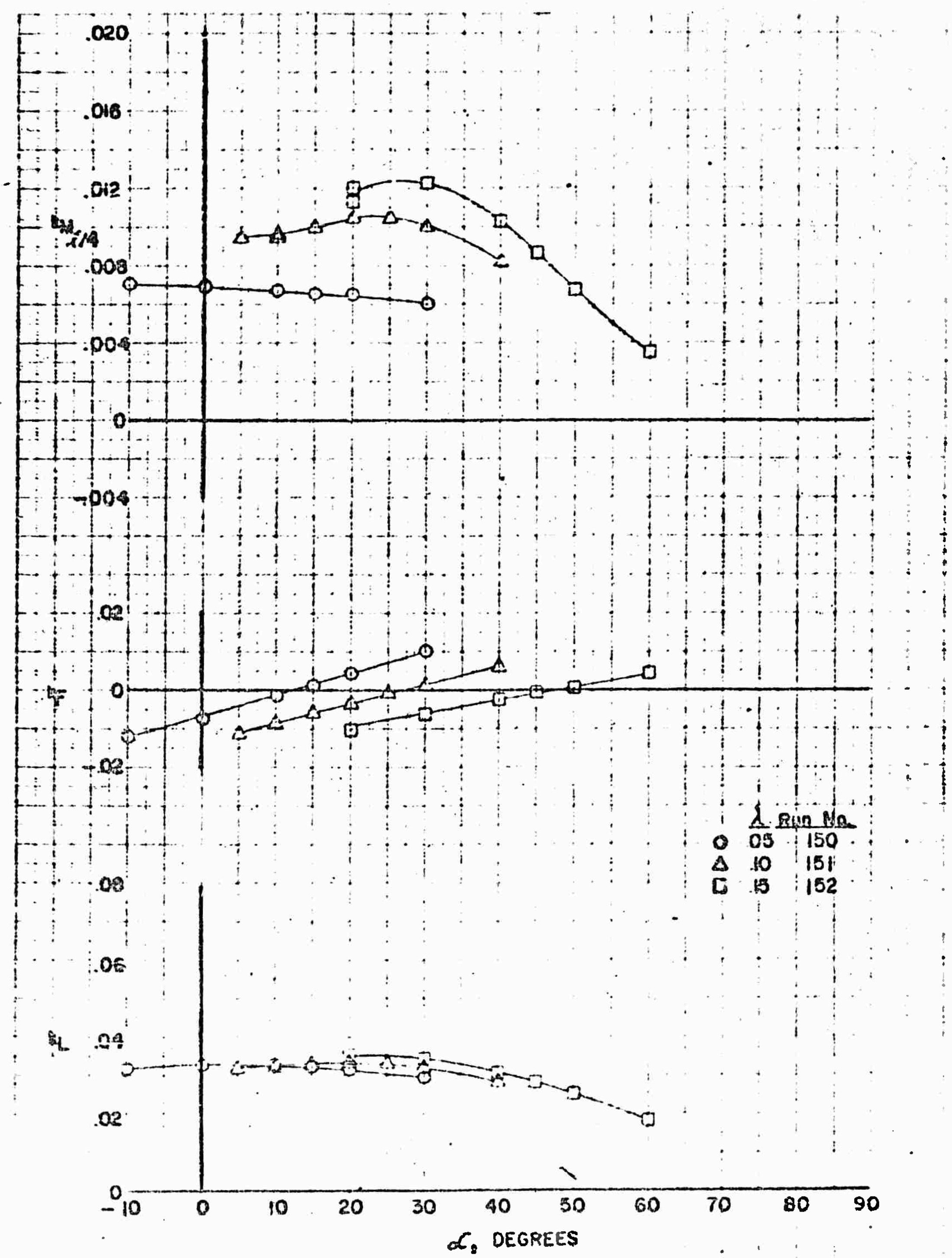

FIGURE 87a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3E

$\beta = 12$

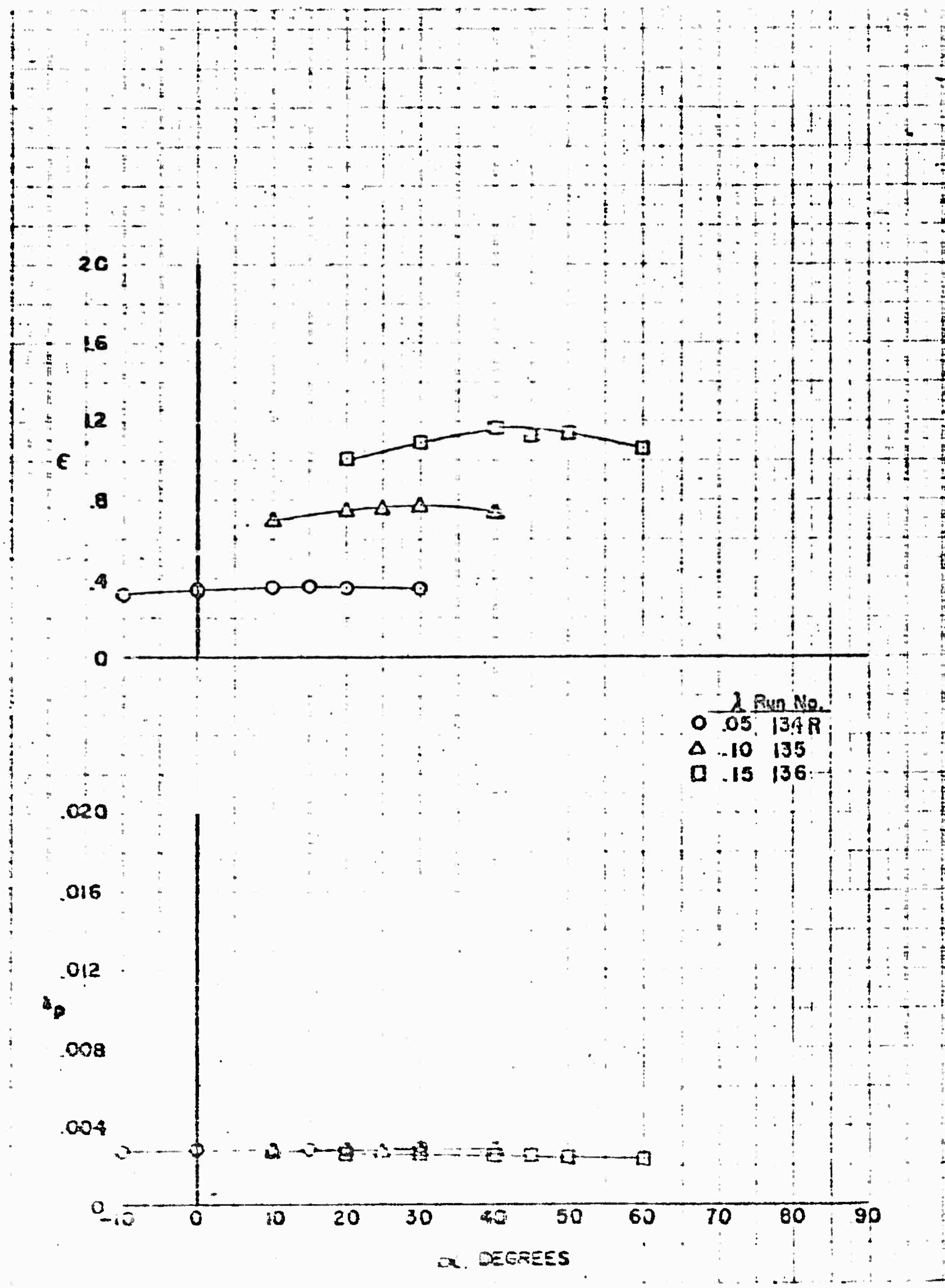

FIGURE 67b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3E
$\beta = 12$

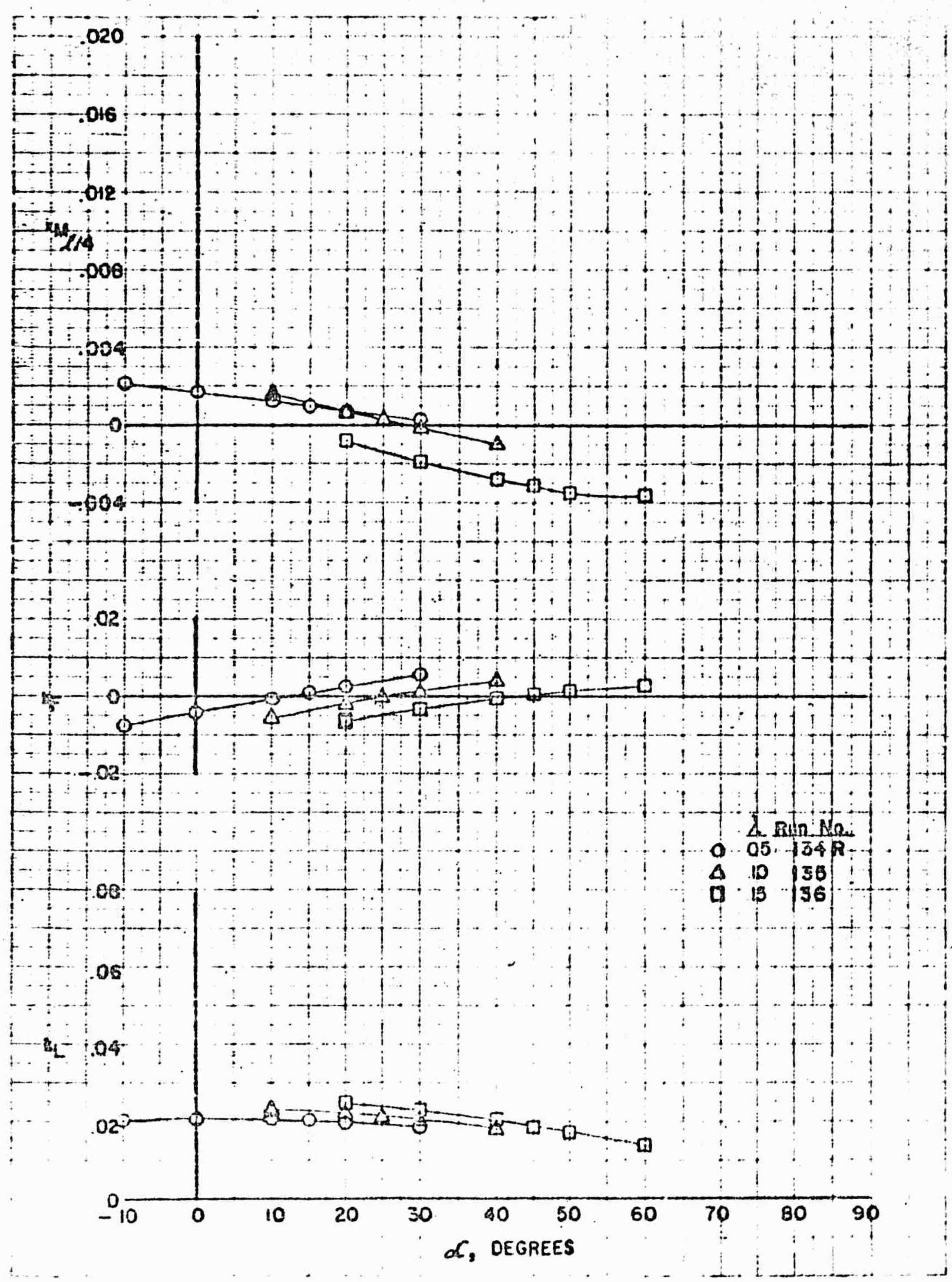

FIGURE 88a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3HE

$\beta = 12$

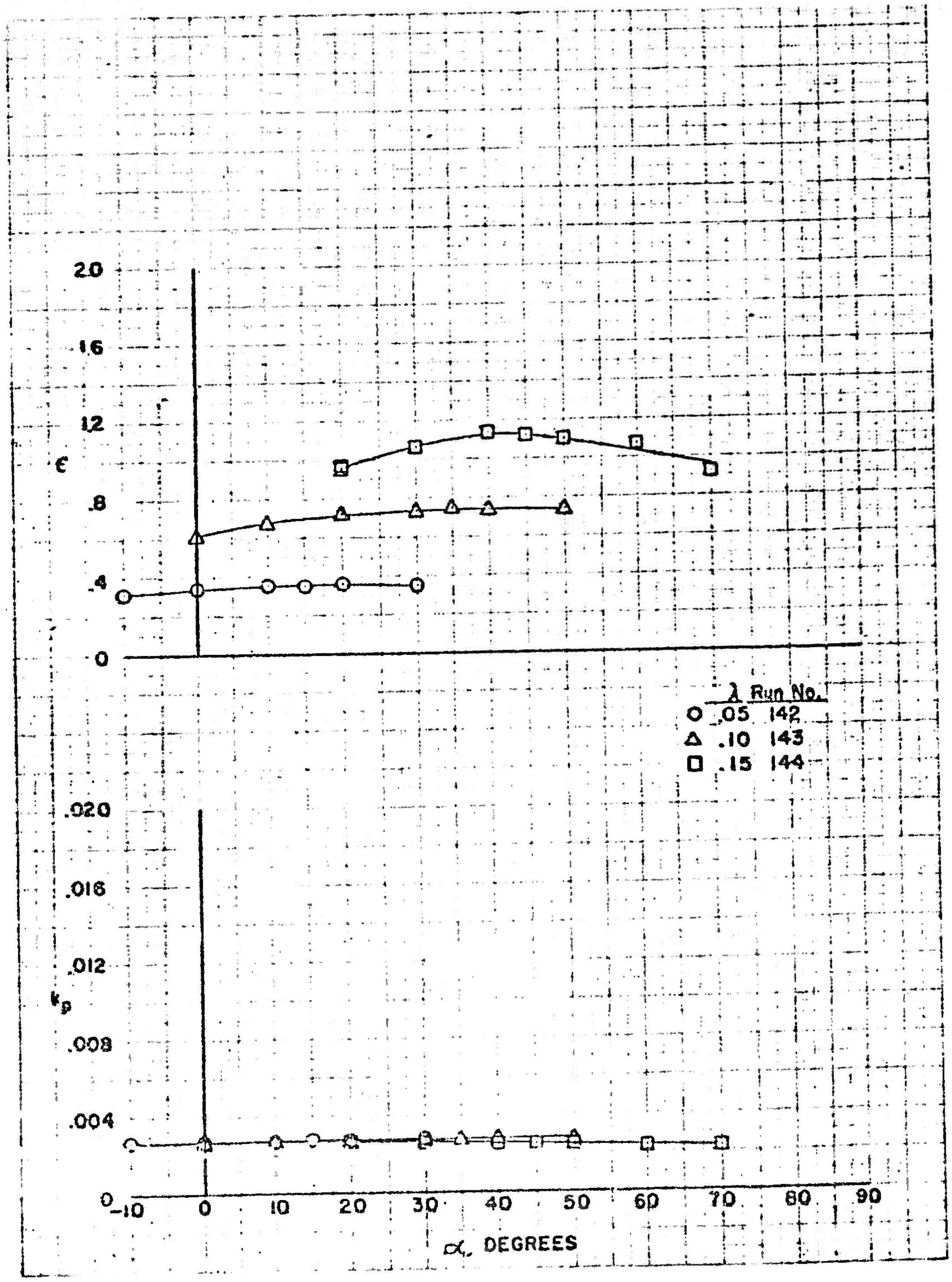

FIGURE 88b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3HE

$\beta = 12$

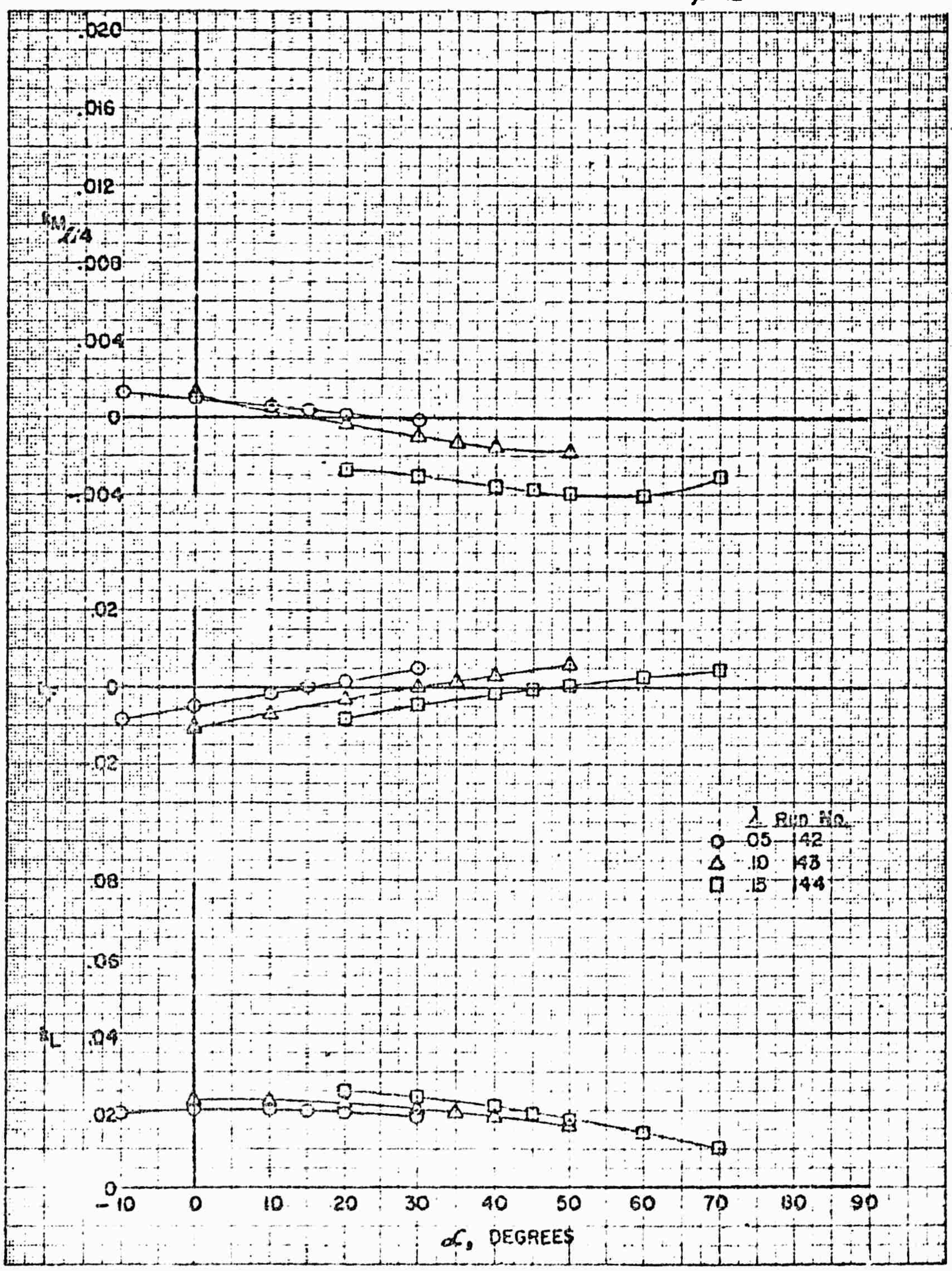

FIGURE 89a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S $\Delta R = .088$

$\beta = 12°$ $\ell_p = 5.13$

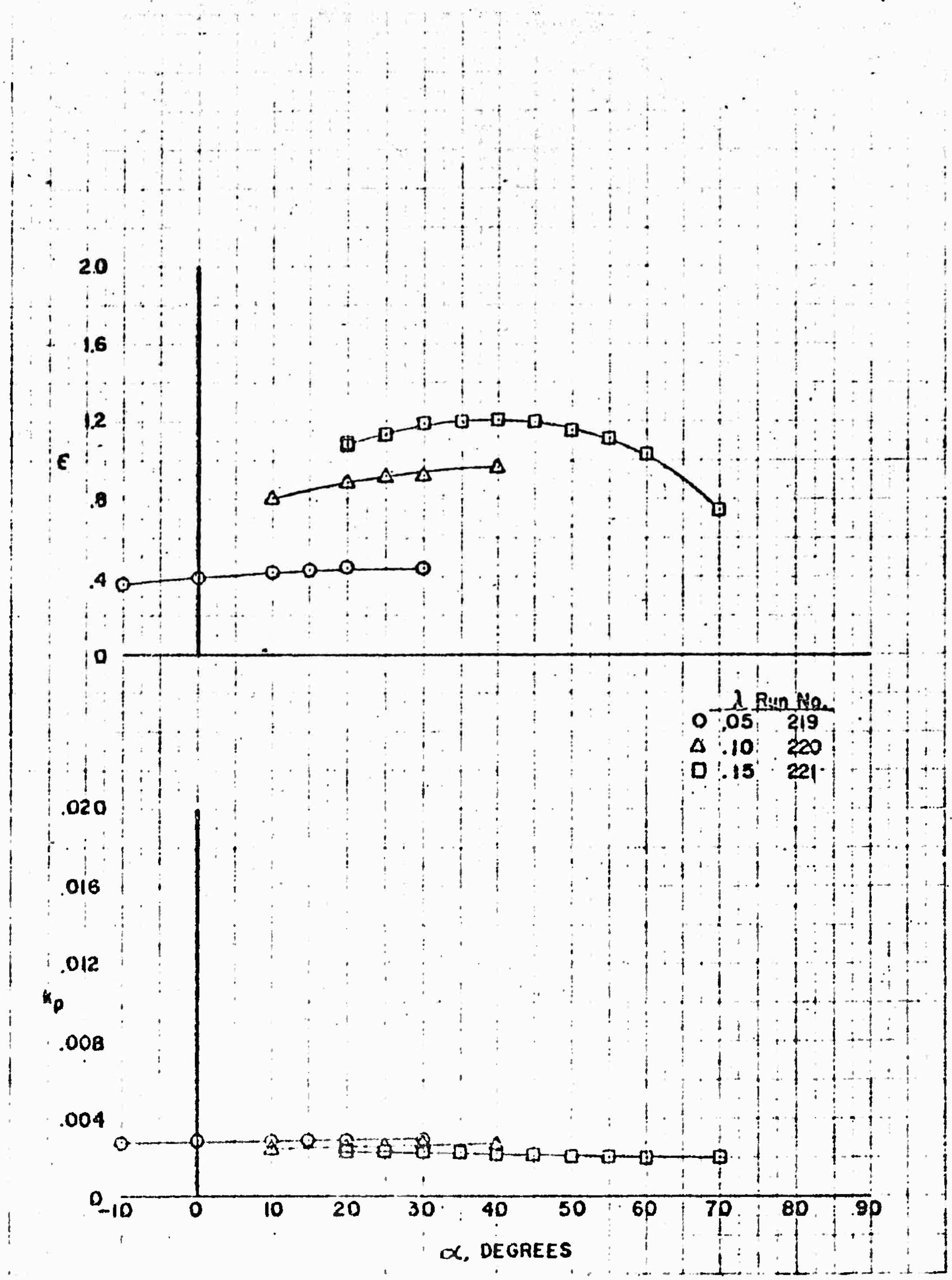

FIGURE 39b. VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

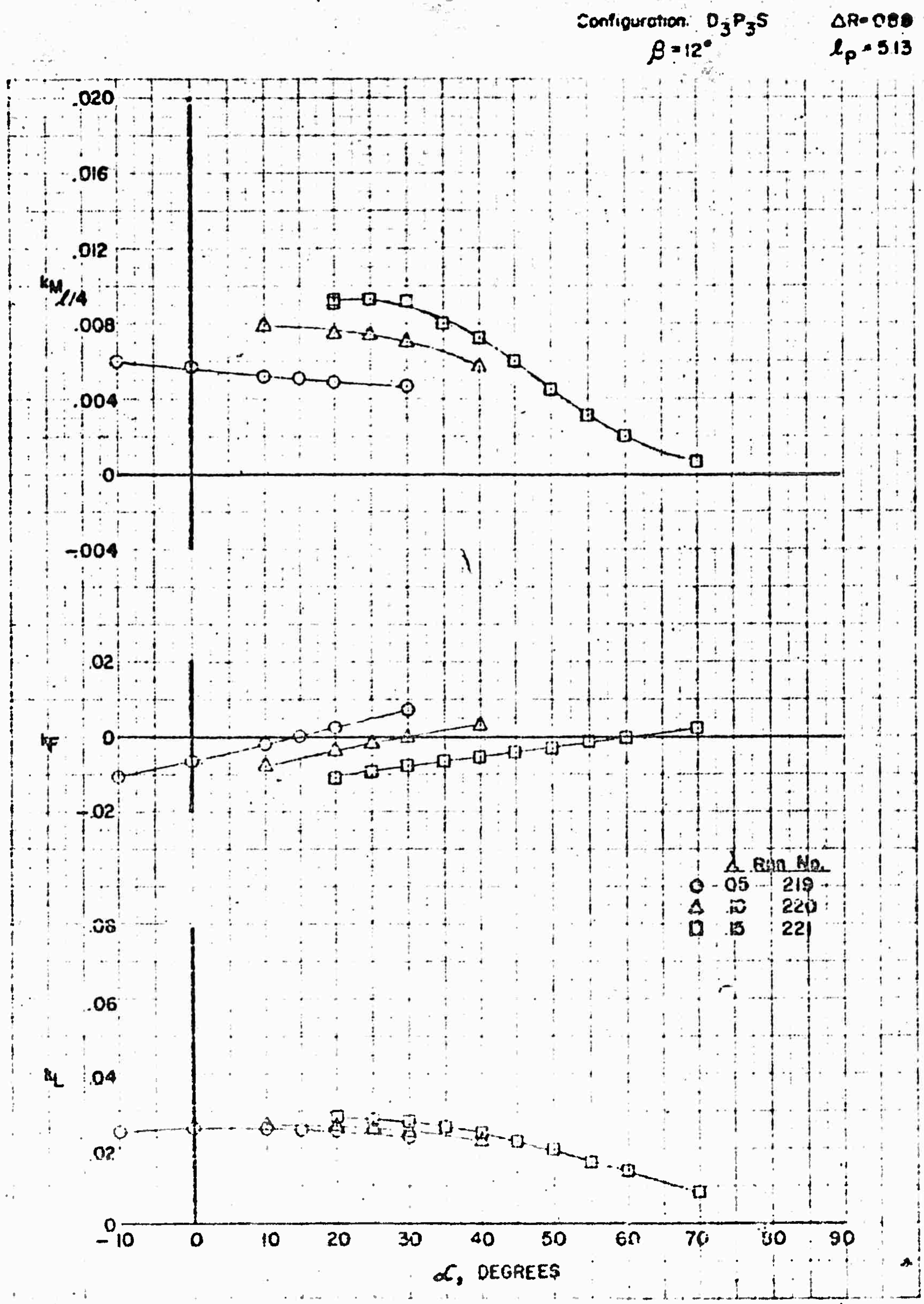

FIGURE 90a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

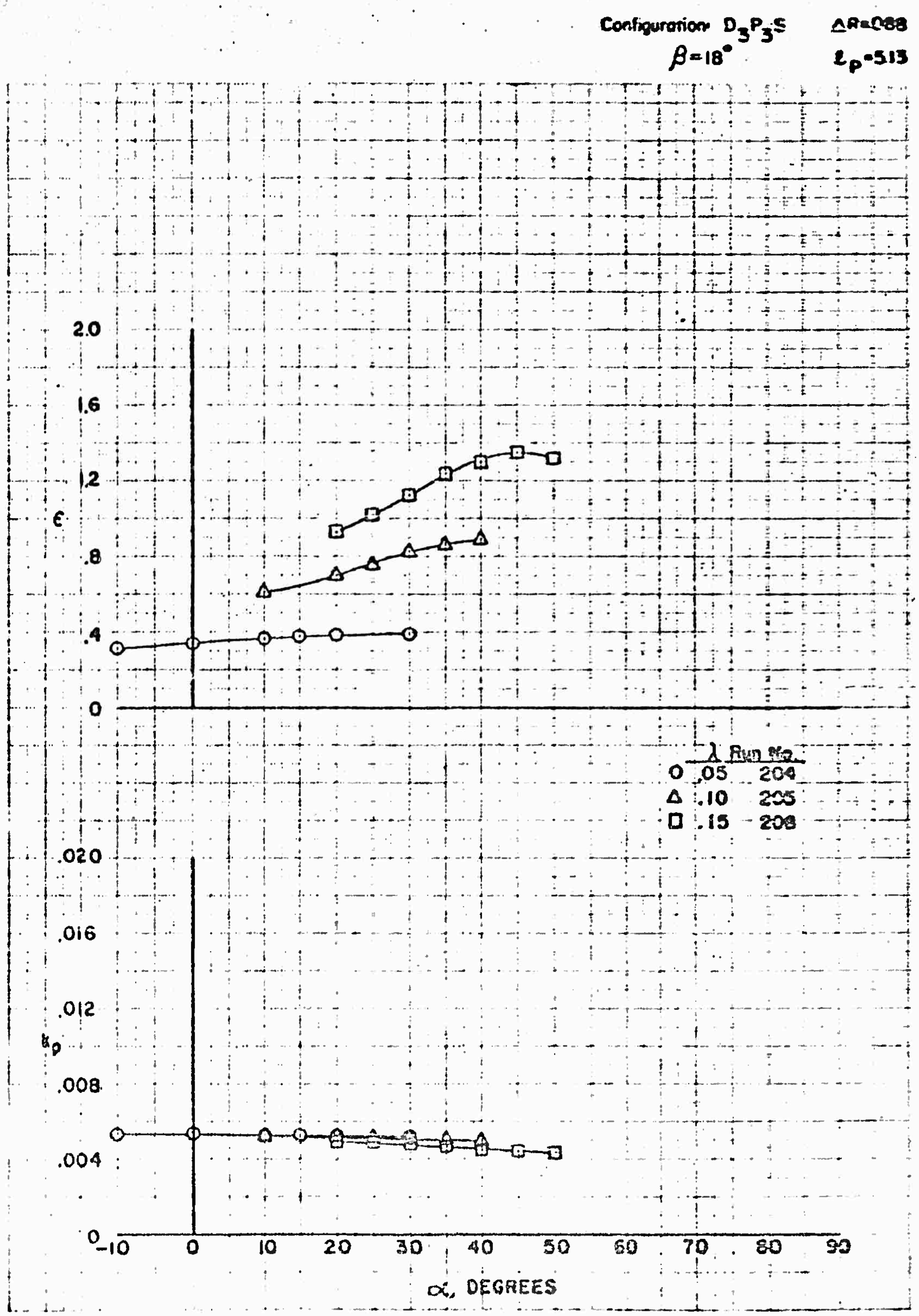

FIGURE 90b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr. 1357 (00) Phase IV

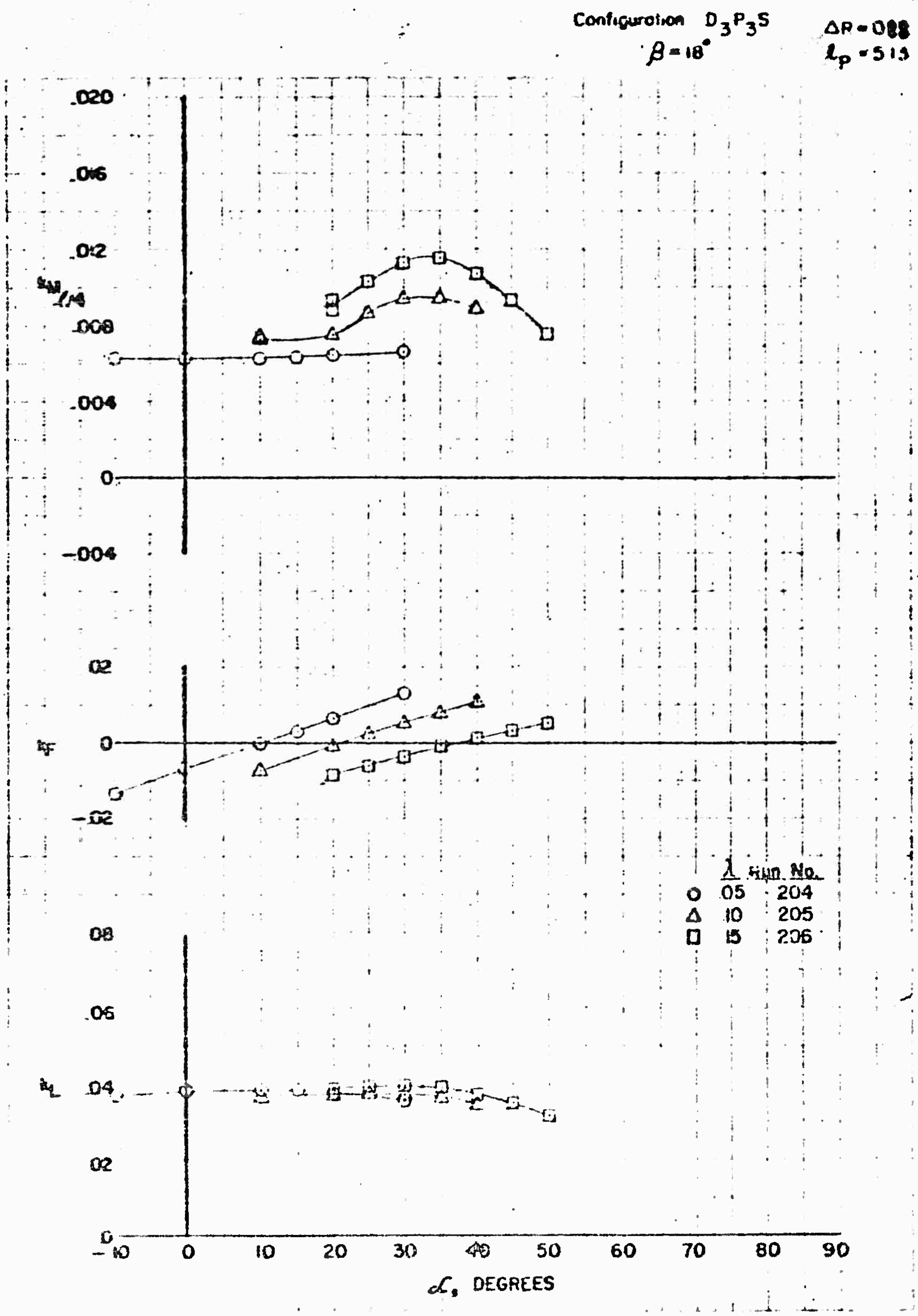

FIGURE 91e VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase II

Configuration D_3P_3S $\Delta R = .046$

$\beta = 12°$ $\ell_p = 4.08$

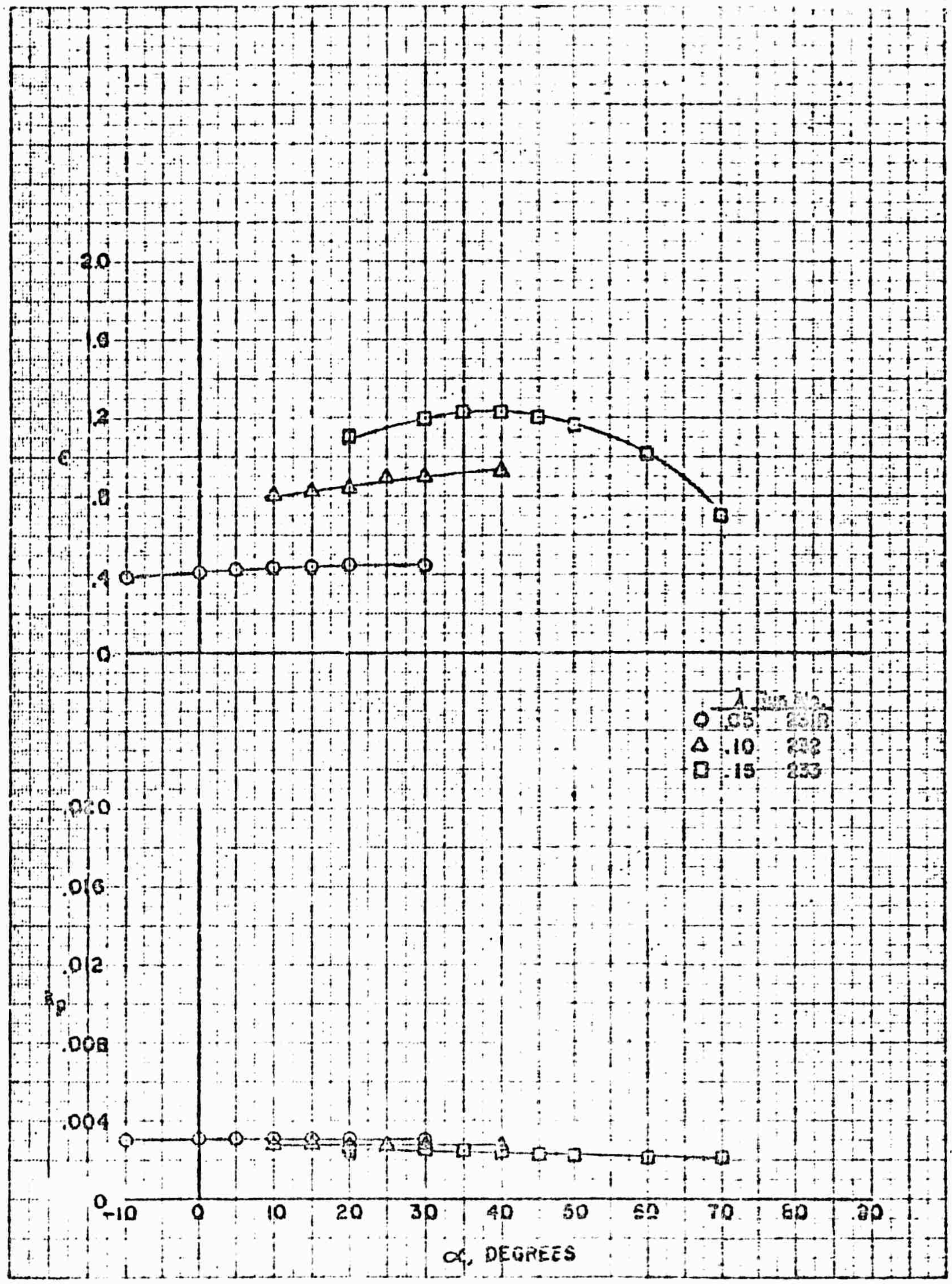

FIGURE [illegible] VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr [illegible]357 (00) Phase IV

Configuration D_3P_3S $\Delta R = .046$

$\beta = 2°$ $\ell_p = 4.08$

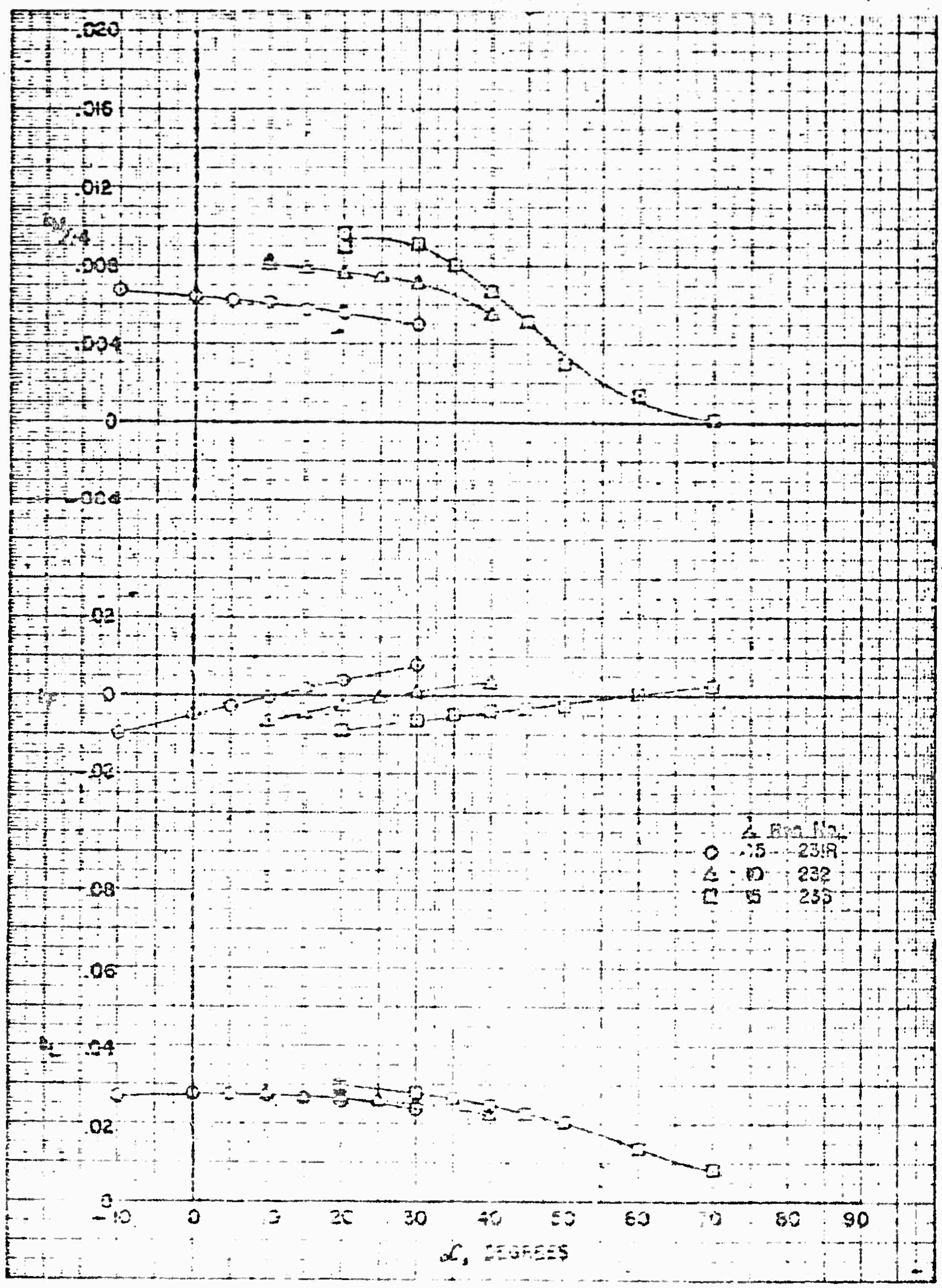

FIGURE 92a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S $\Delta R = .046$

$\beta = 18°$ $\ell_p = 4.08$

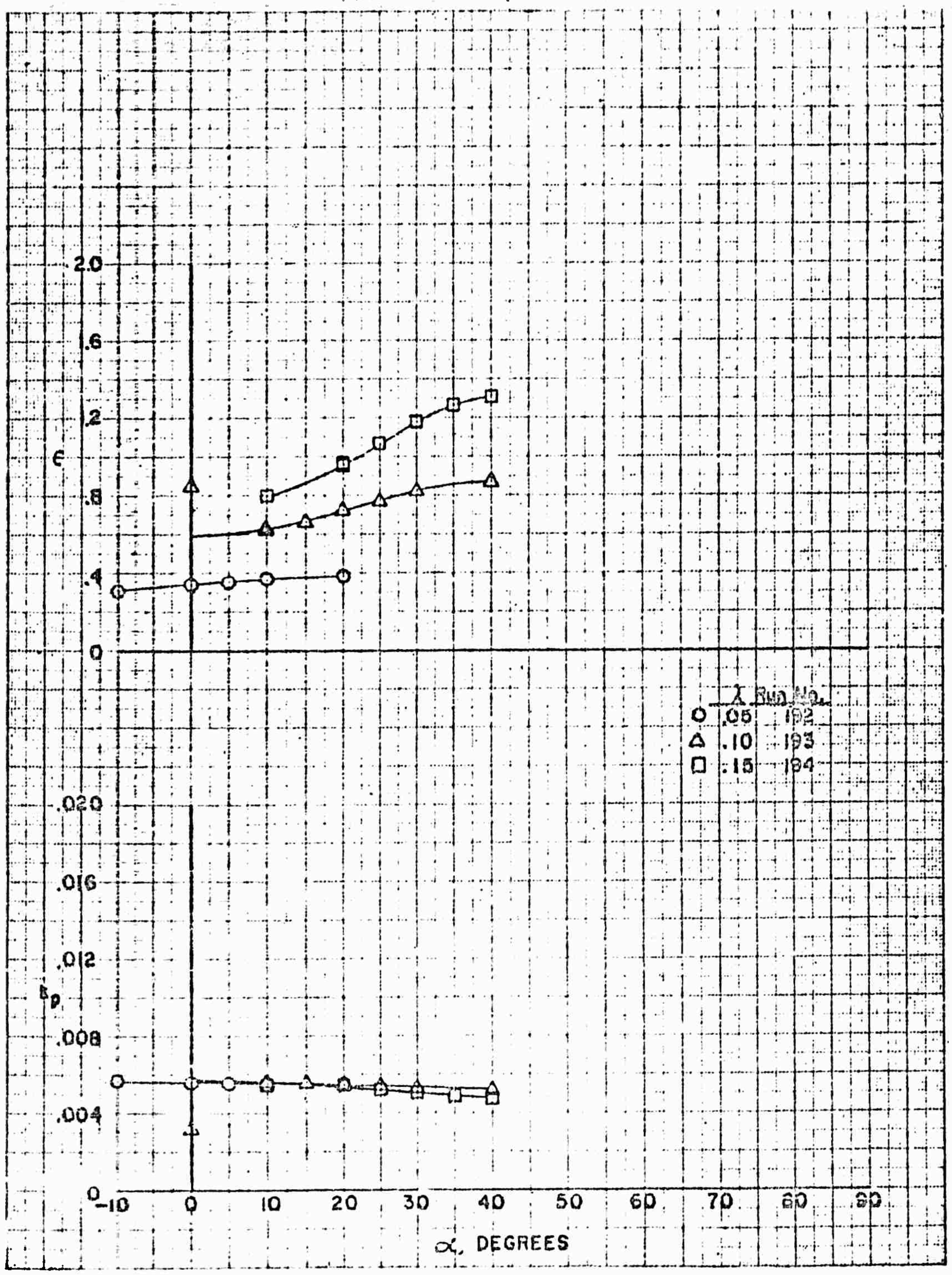

FIGURE 92b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S $\Delta R = .046$

$\beta = 18°$ $l_p = 4.08$

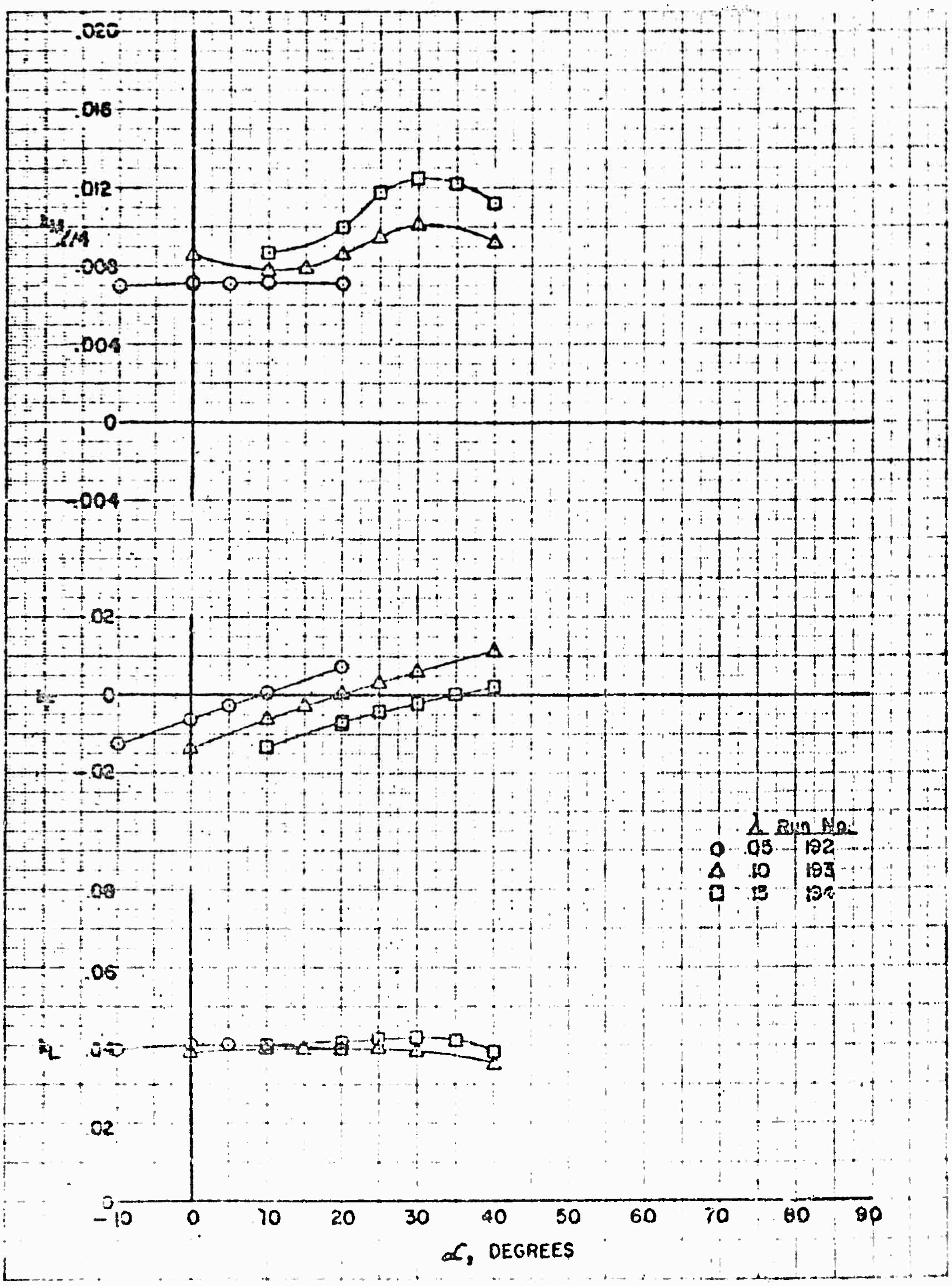

FIGURE 93a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S $\Delta R = .088$

$\beta = 12°$ $\ell_p = 4.08$

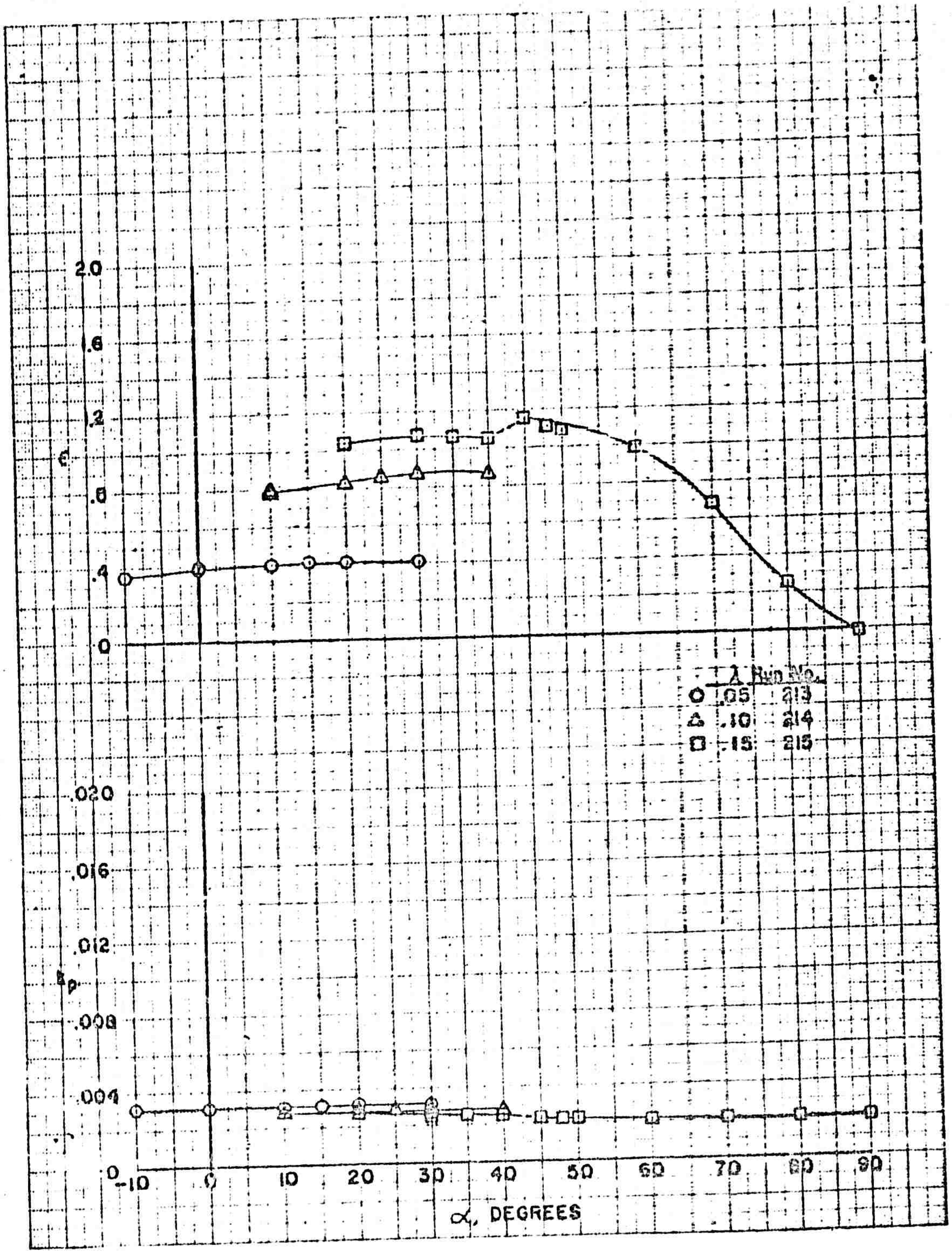

FIGURE 93b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE.

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S ΔR = .088

$\beta = 12°$ $\ell_p = .408$

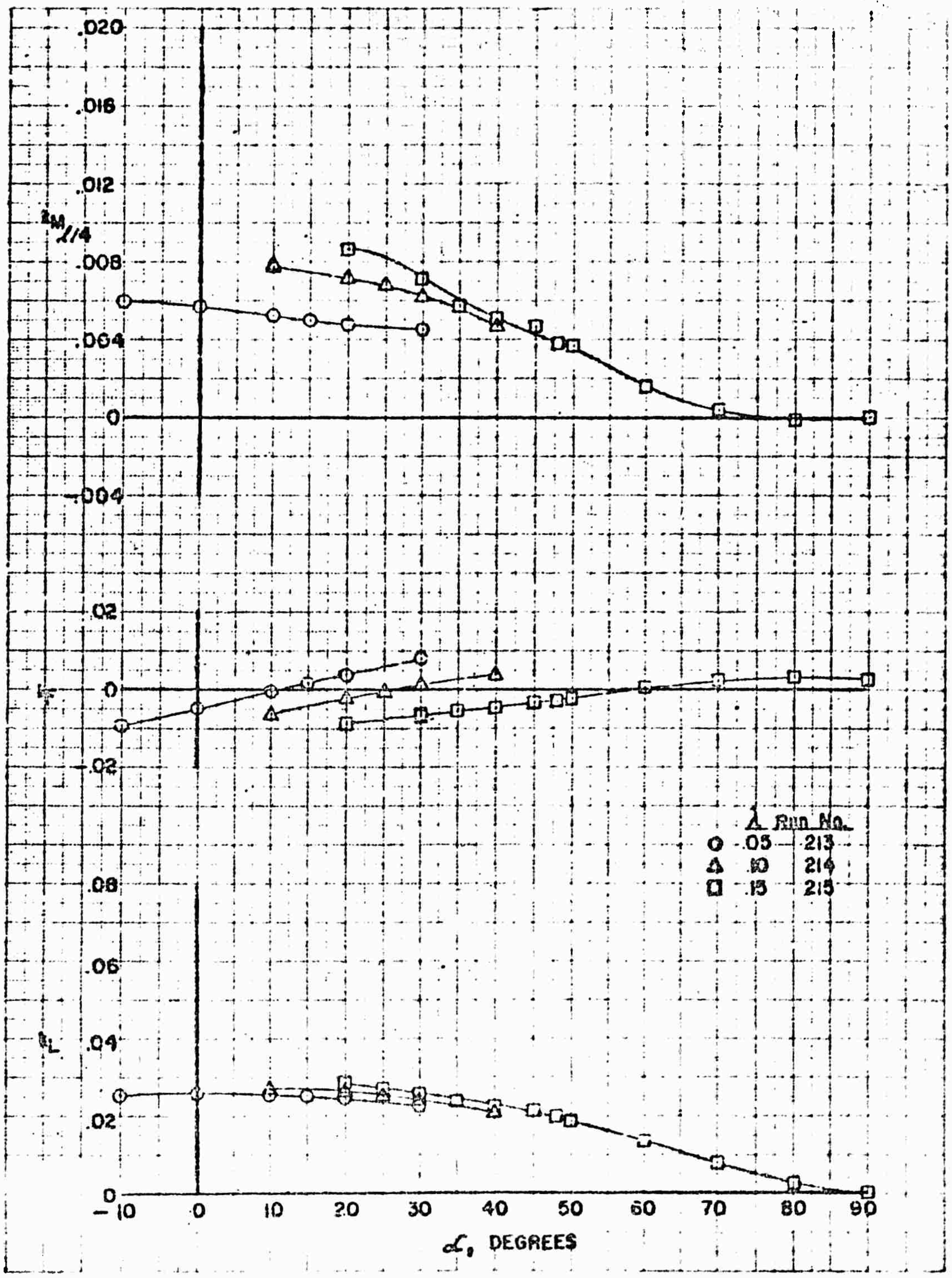

FIGURE 94a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

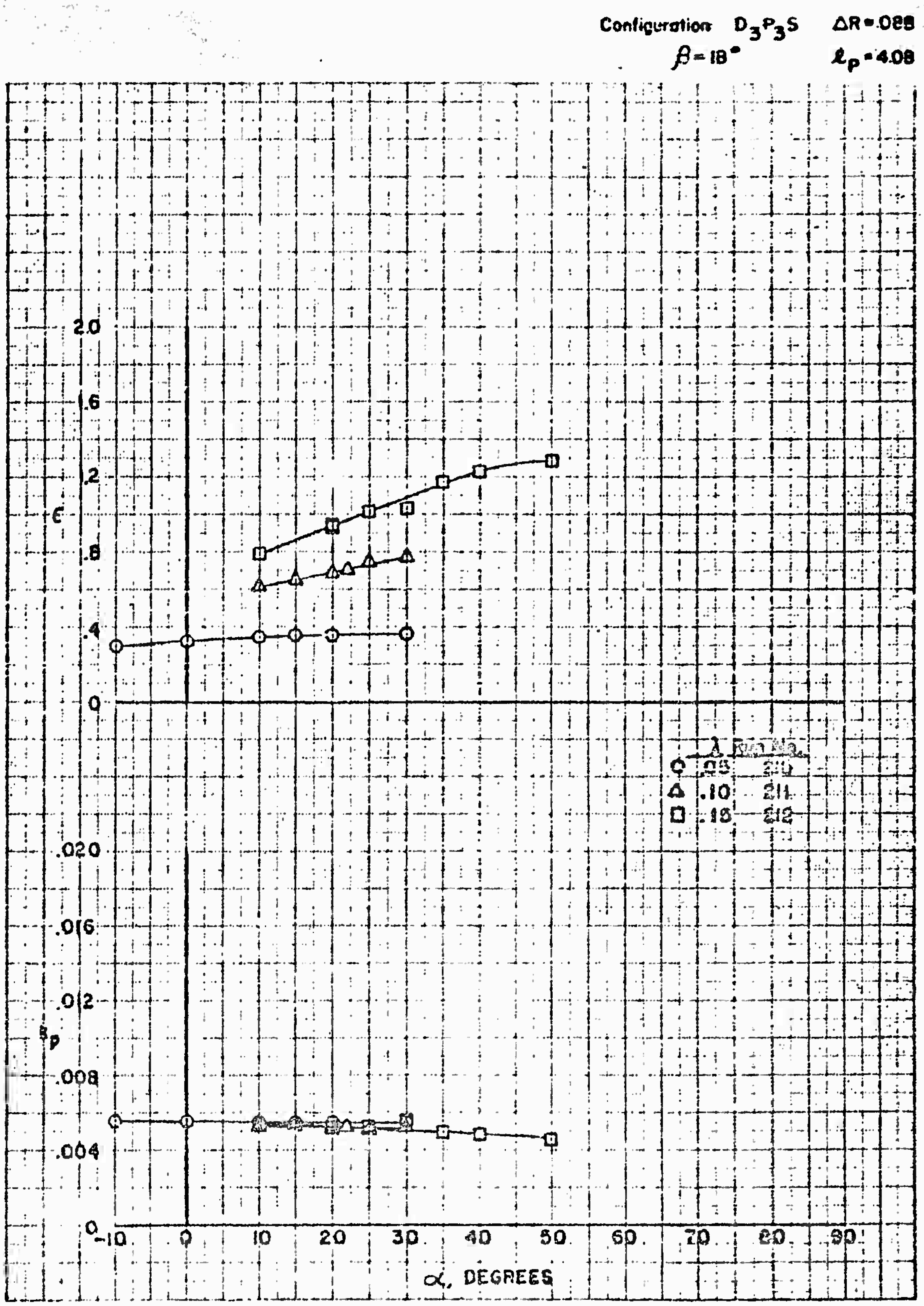

FIGURE 94b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S ΔR = .088

β = 18° ℓ_p = 4.08

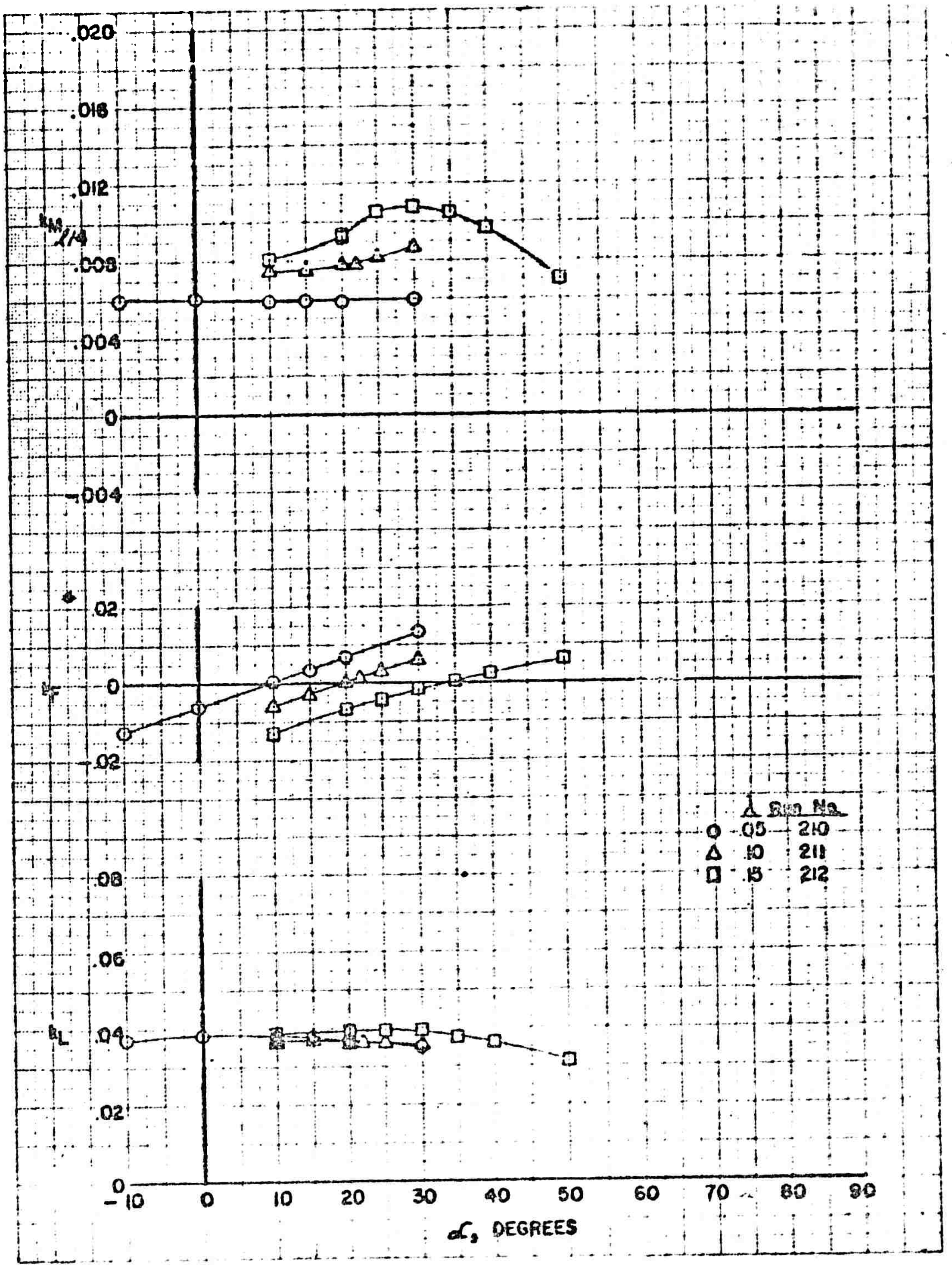

FIGURE 95a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P'_3S$ $\Delta R = .046$

$\beta = 12°$ $\ell_p = 2.59$

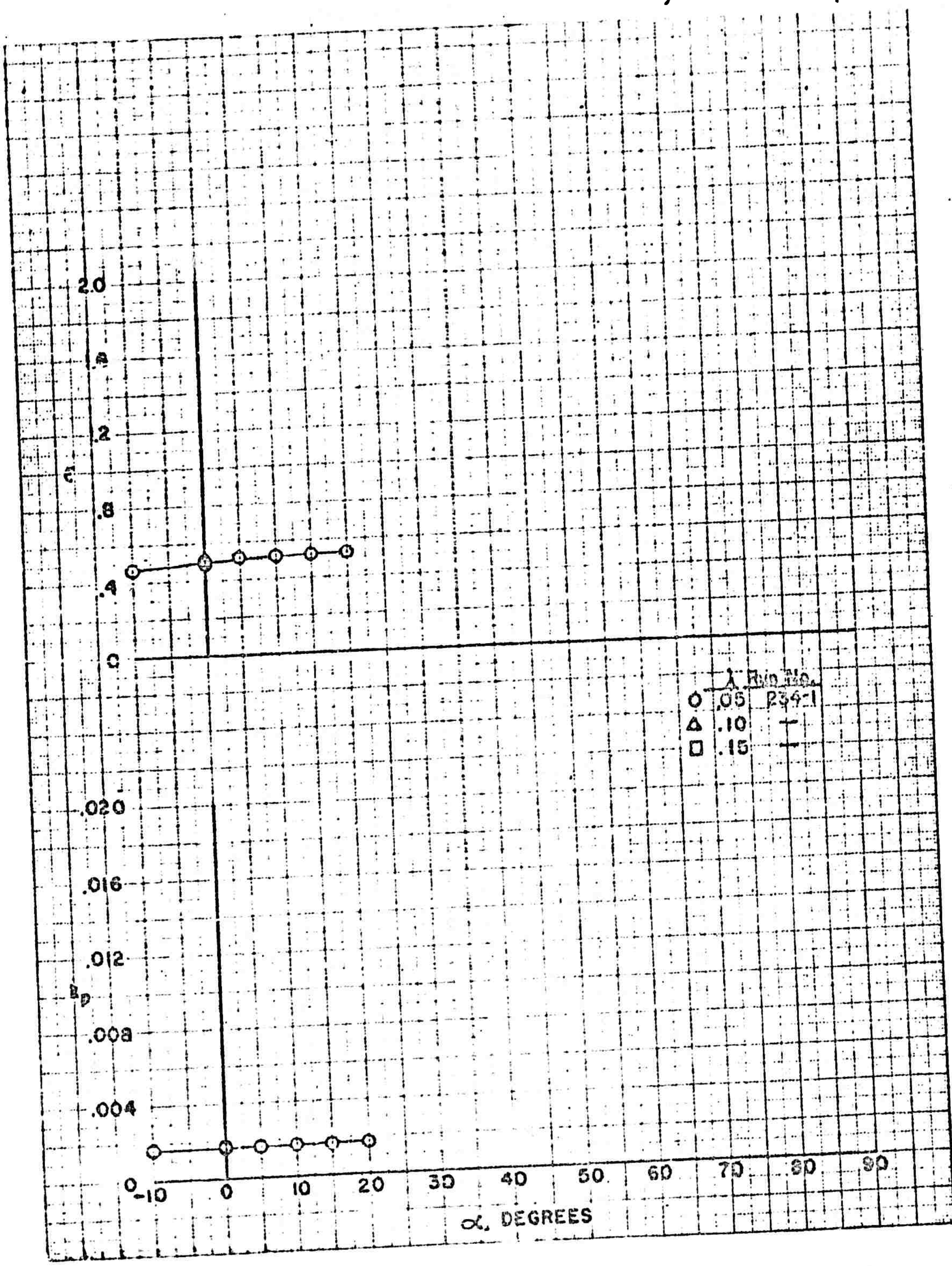

FIGURE 95b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase II

Configuration D_2P_3S $\Delta R = 046$

$\beta = 2°$ $\ell_p = 259$

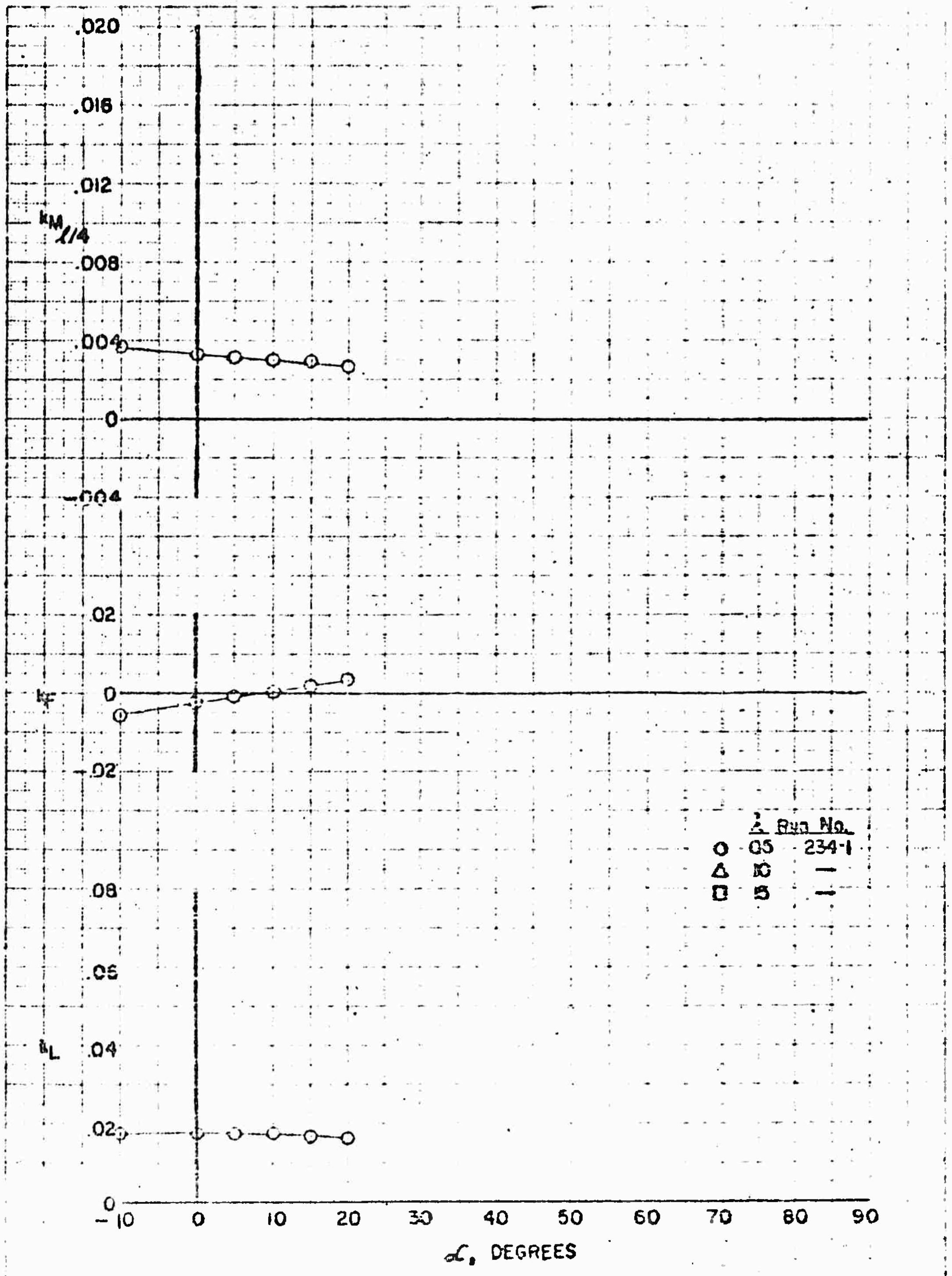

FIGURE 96a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3'S$ $\Delta R = .046$

$\beta = 21°$ $\ell_p = 2.59$

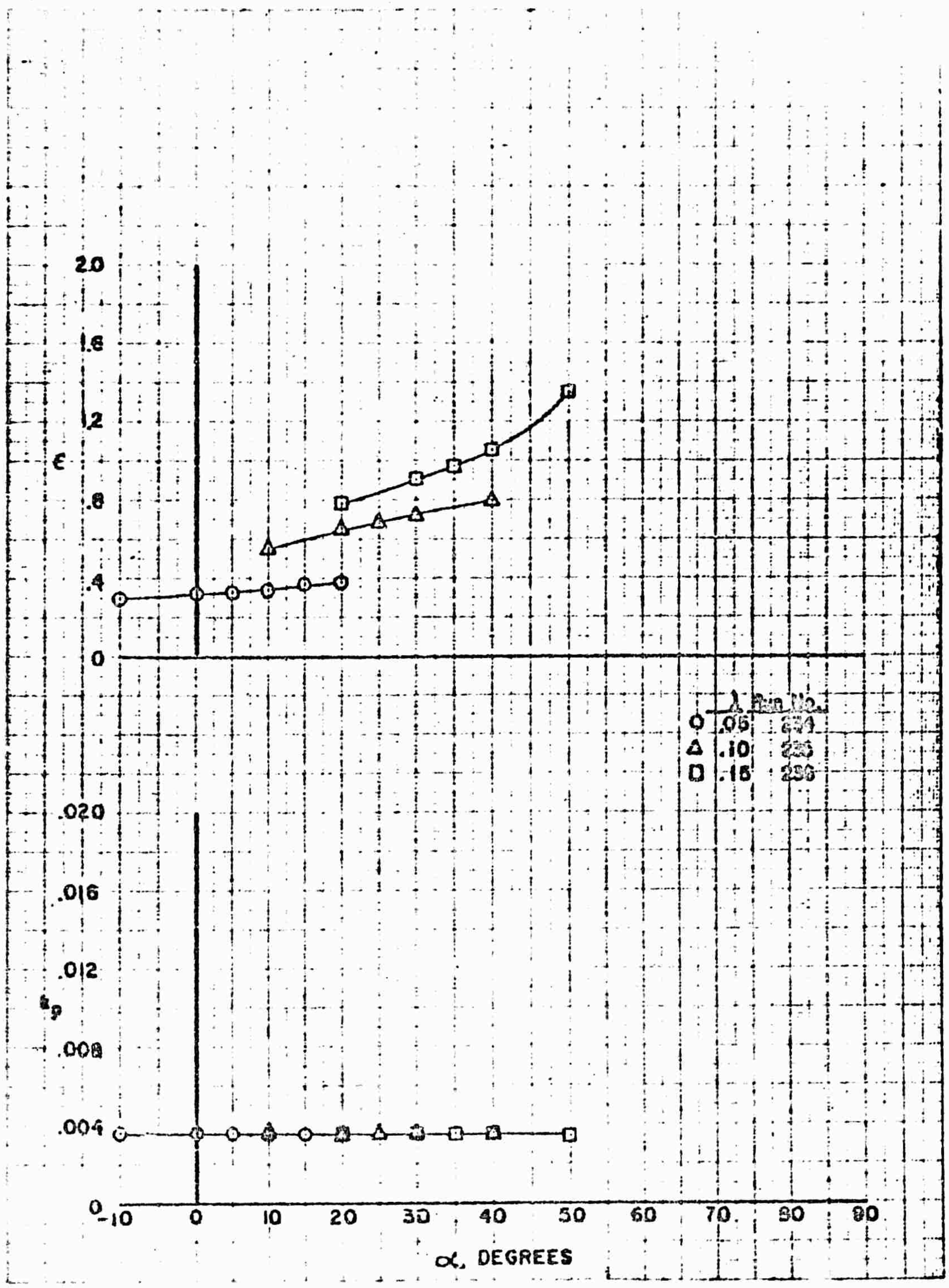

FIGURE 96b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P'_3S$ $\Delta R = .046$

$\beta = 21°$ $\ell_p = 2.59$

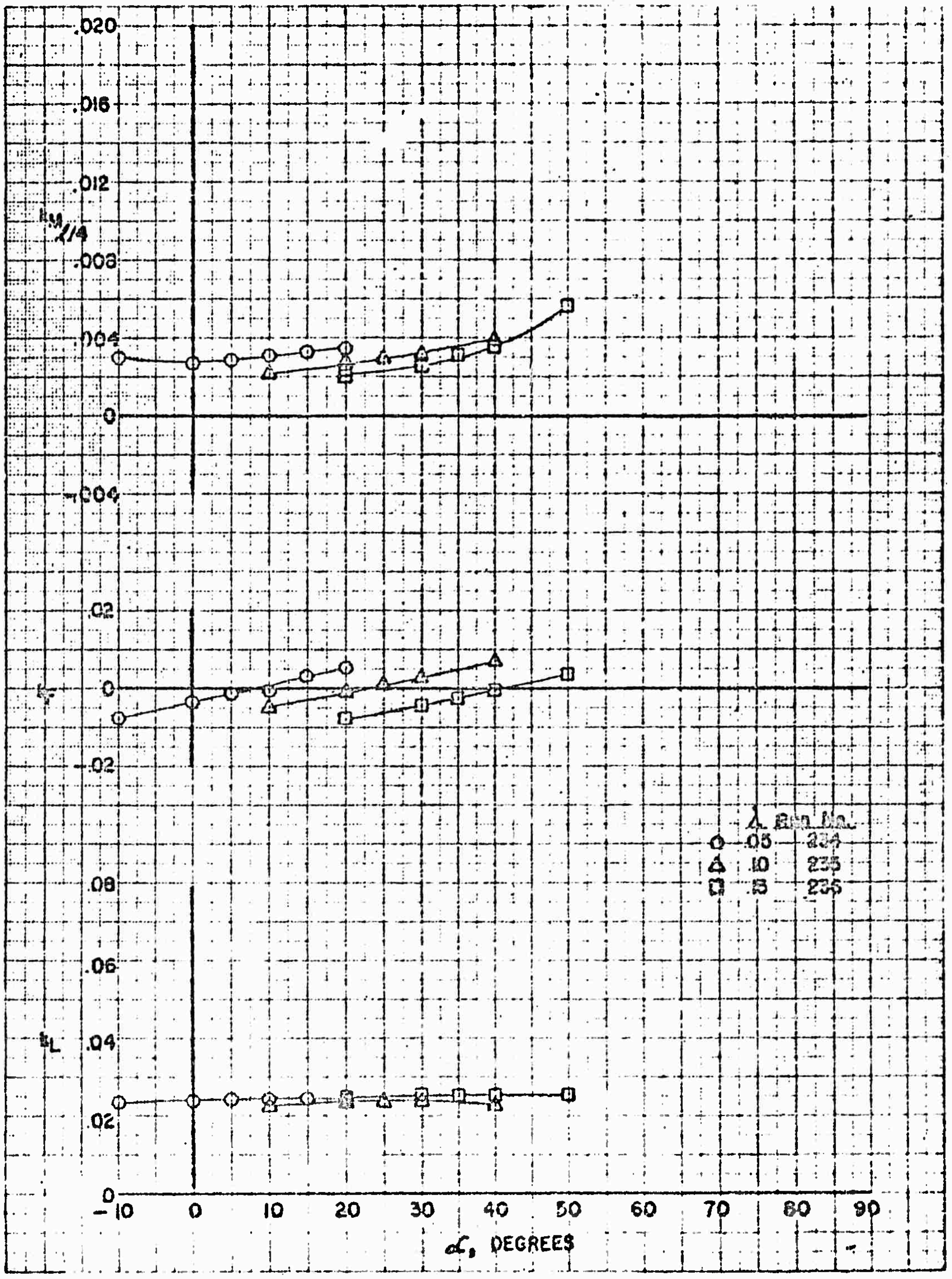

FIGURE 97a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P_3'S$ $\Delta R = .046$

$\beta = 30°$ $\ell_p = 2.59$

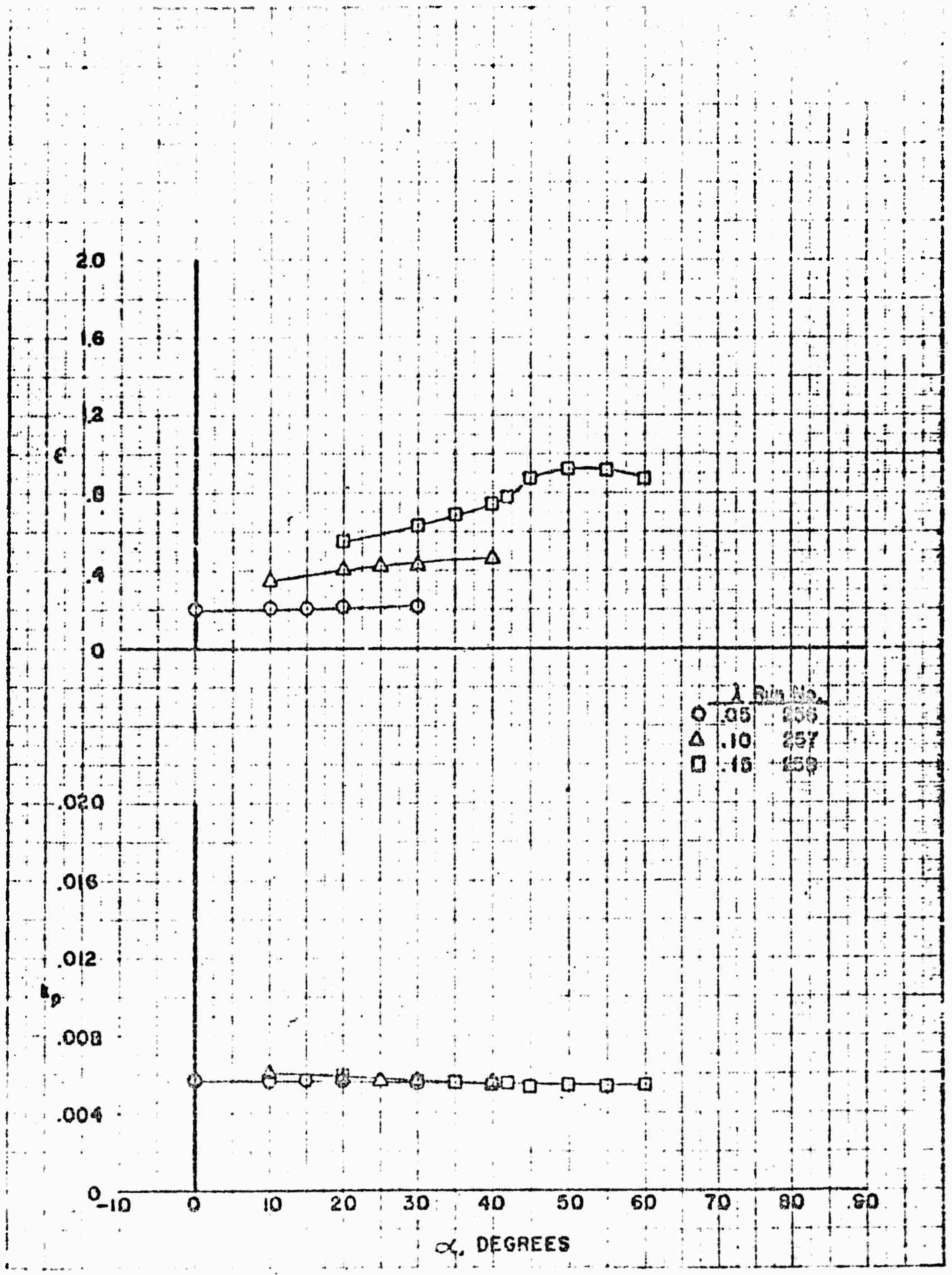

FIGURE 97b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

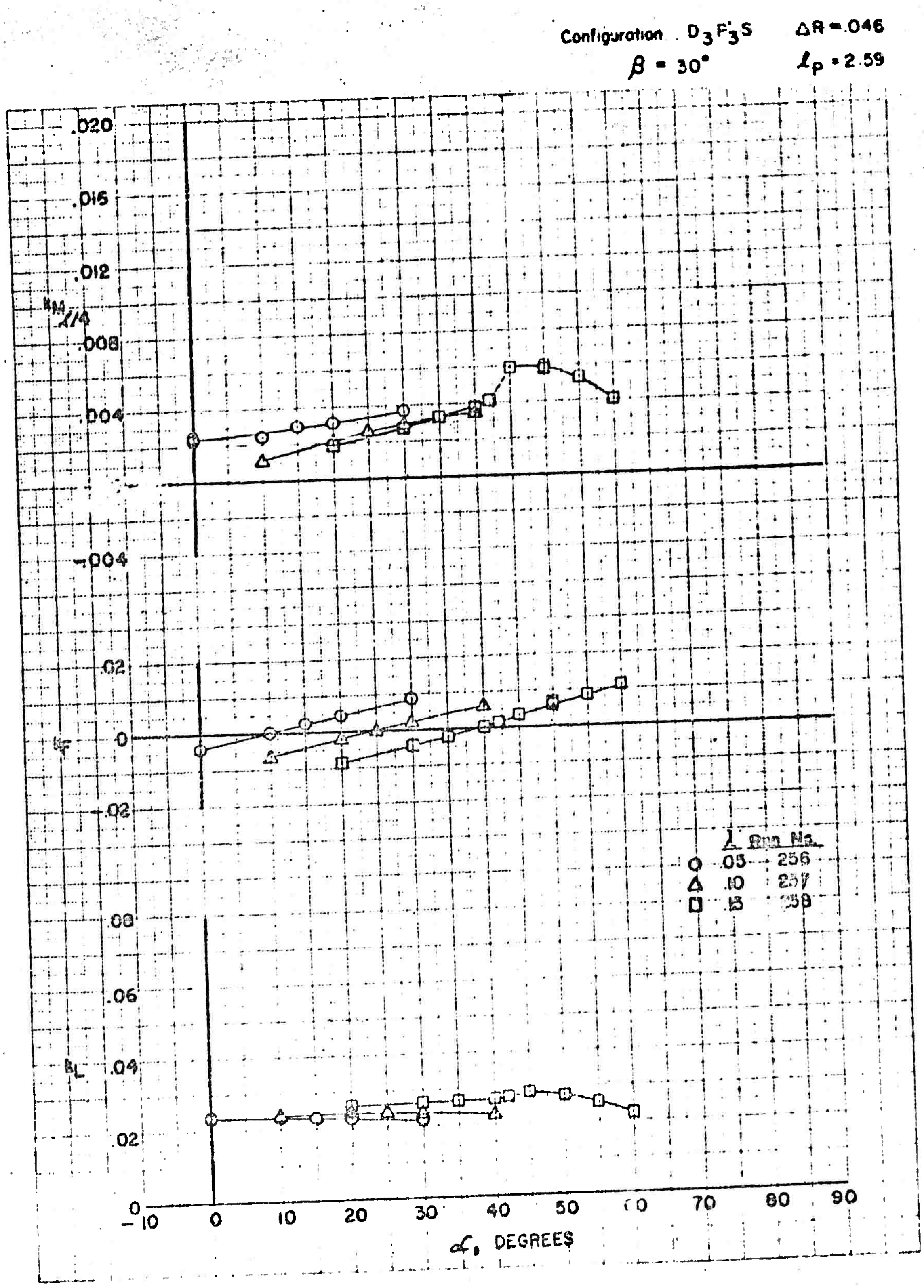

FIGURE 98a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3'S$ $\Delta R = .088$

$\beta = 30°$ $\ell_p = 2.59$

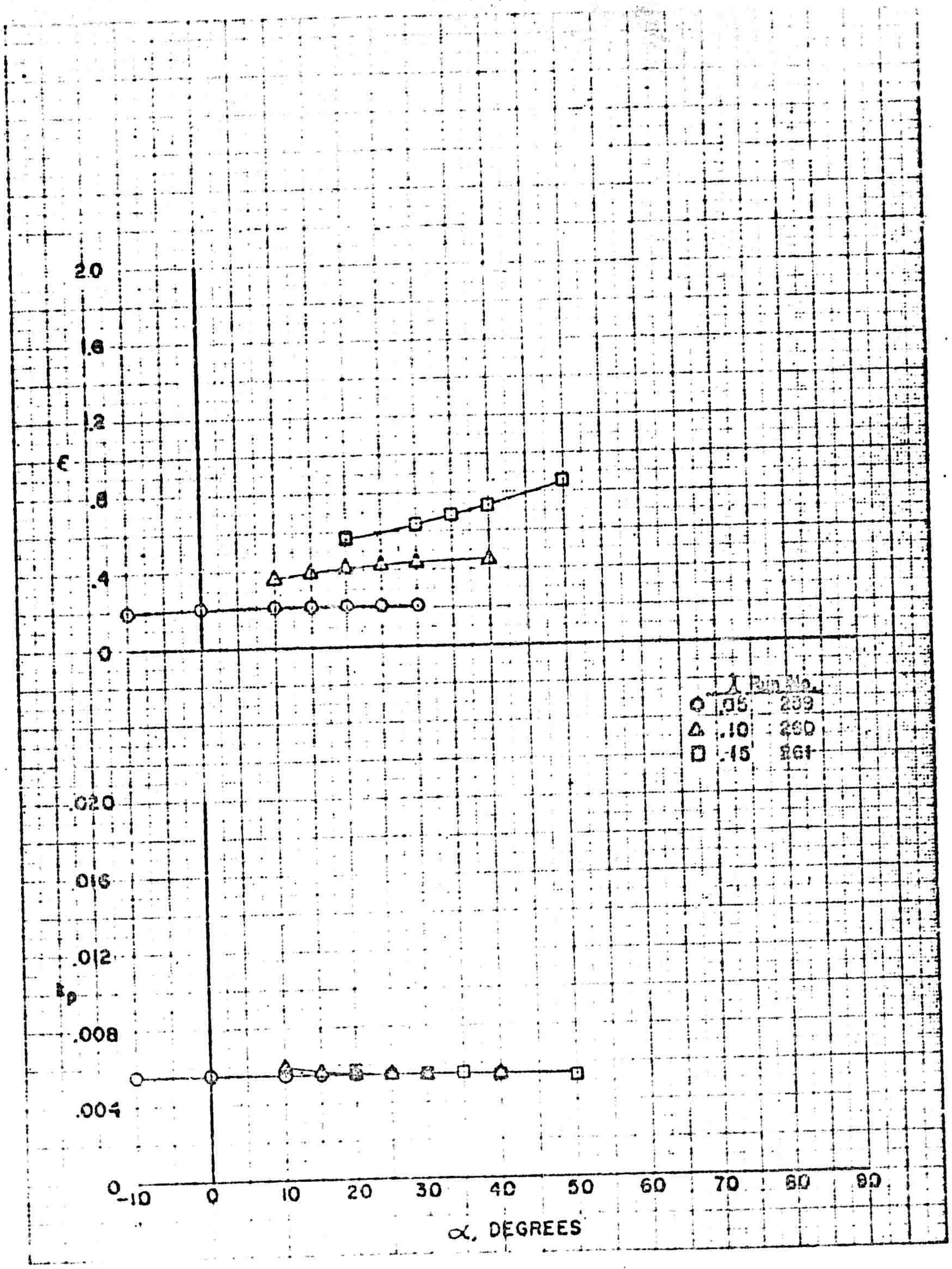

FIGURE 98b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr -1357 (00) Phase IV

Configuration $D_3P'_3S$ $\Delta R = .088$

$\beta = 30°$ $\ell_p = 2.59$

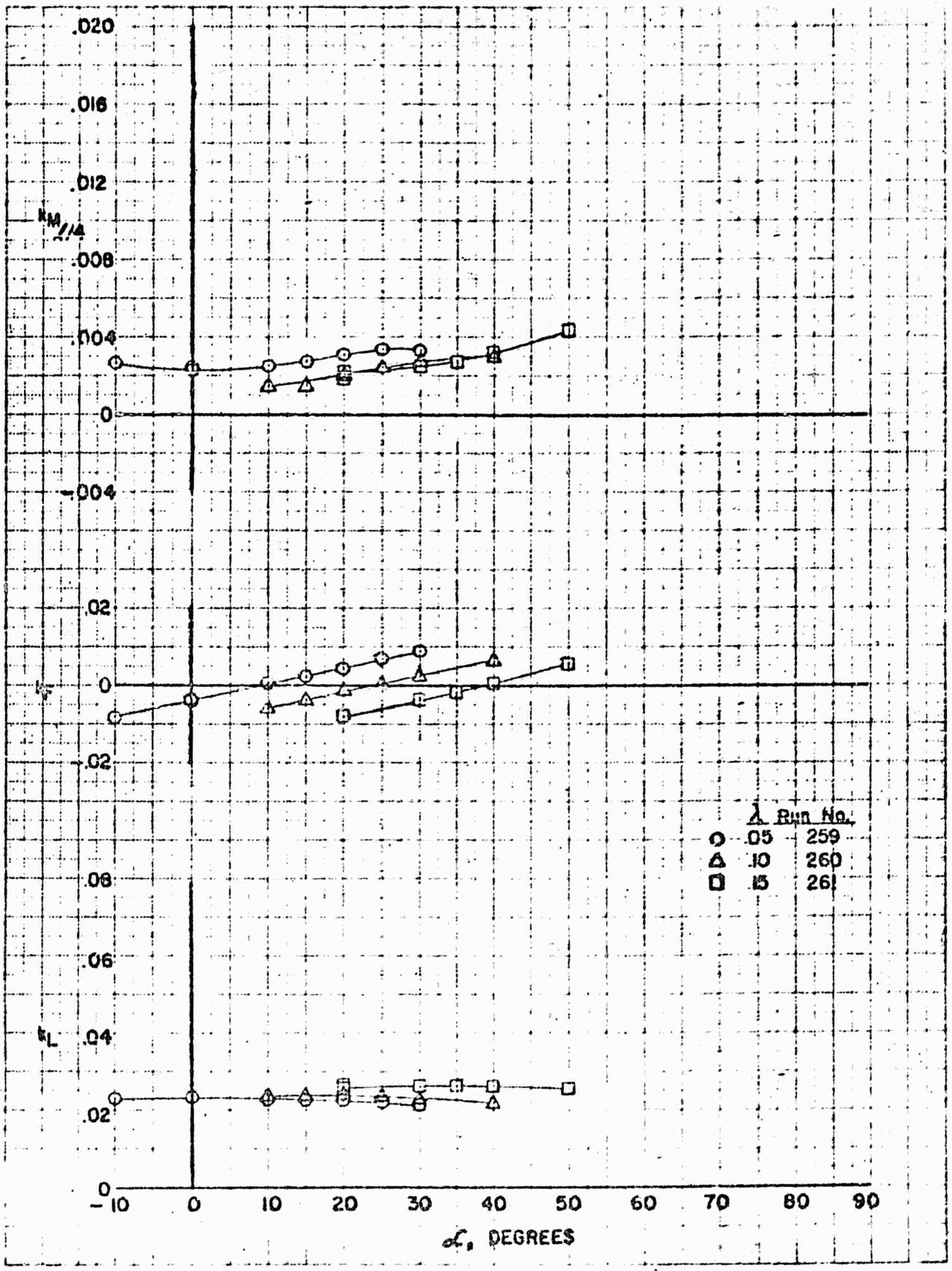

FIGURE 99a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\beta = 30°$

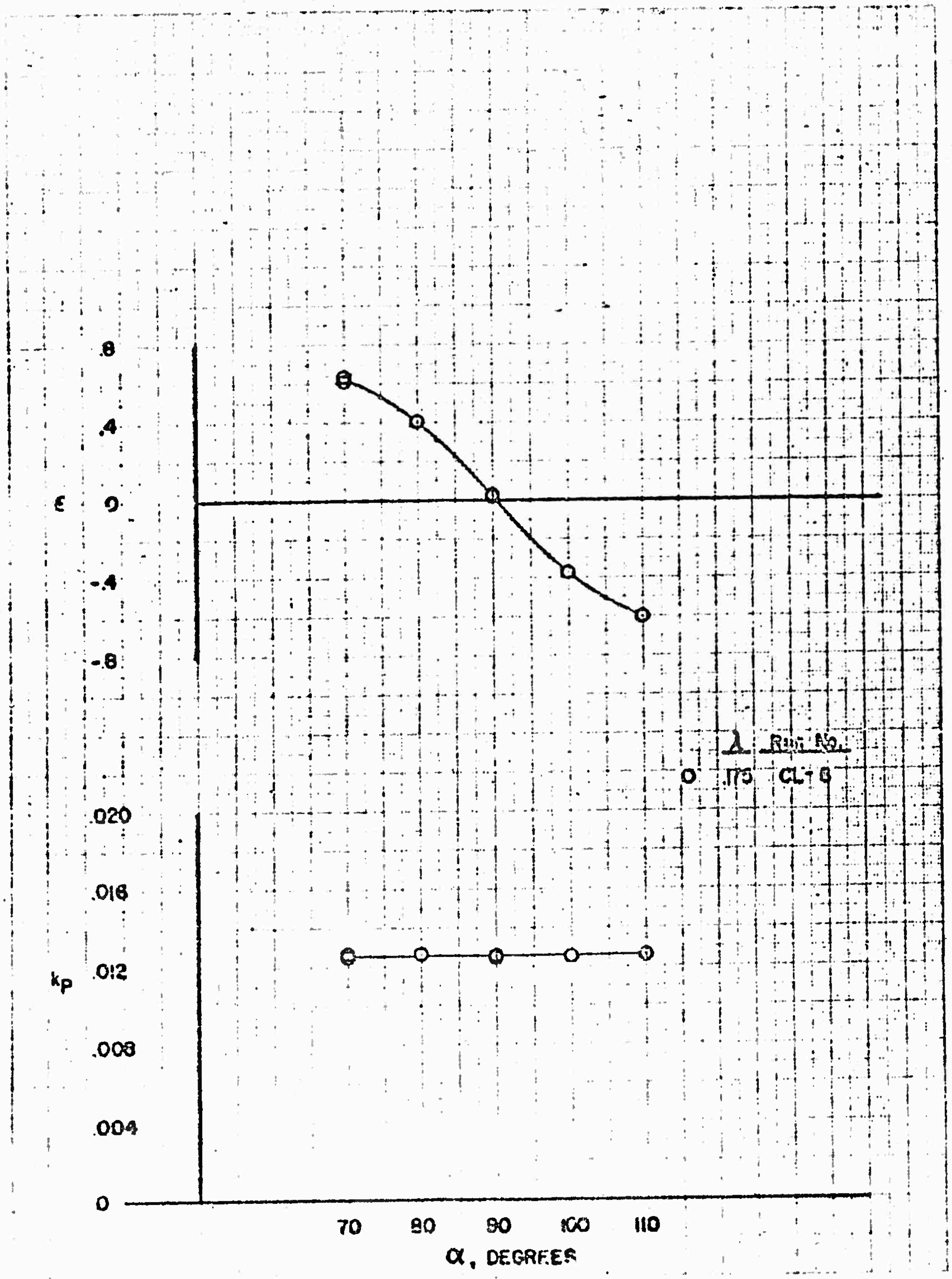

FIGURE 99b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

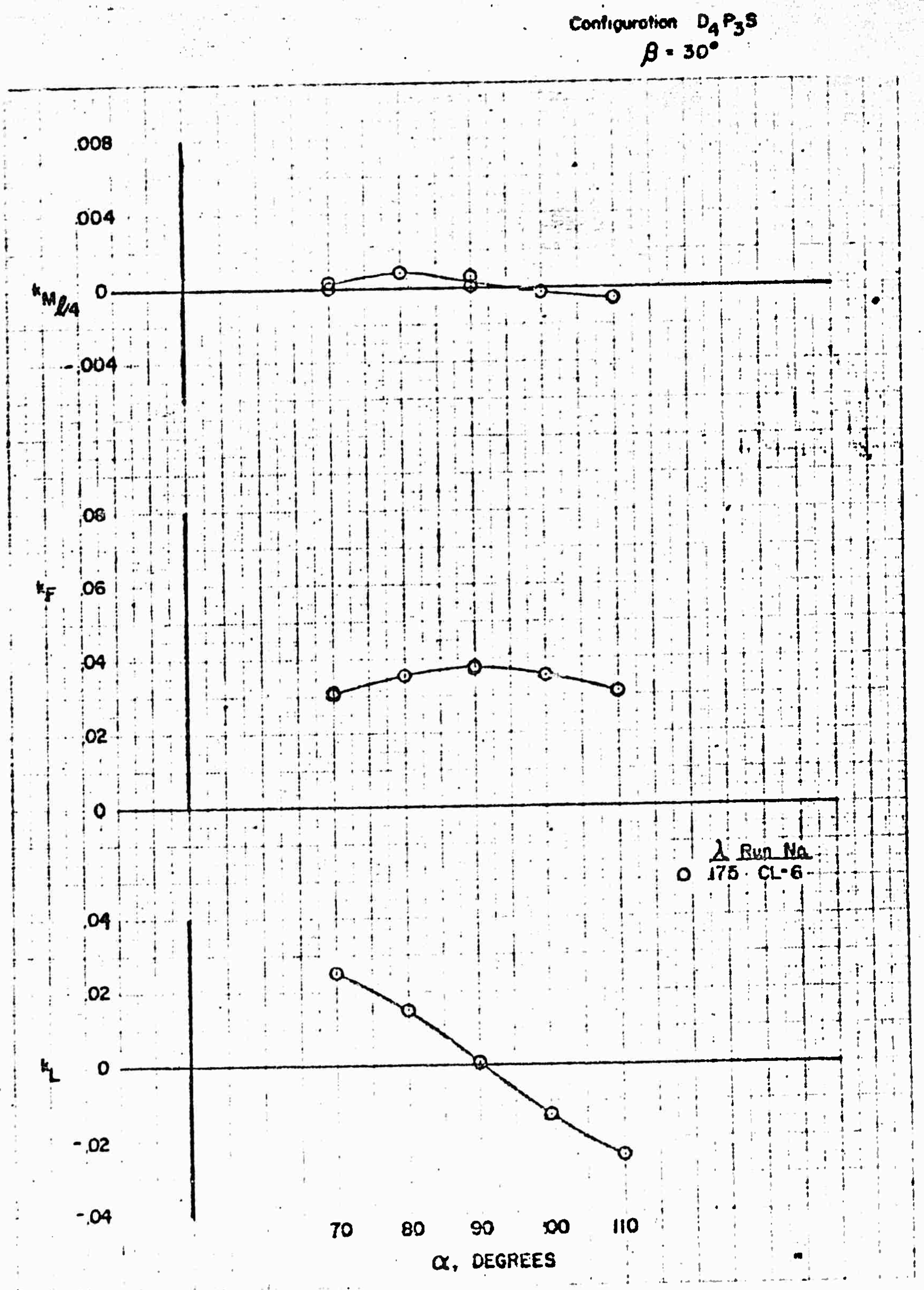

FIGURE 100a VARIATION OF DUCTED PROPELLER POWER COEFFICIENT AND EFFICIENCY WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S

$\beta = 12°$

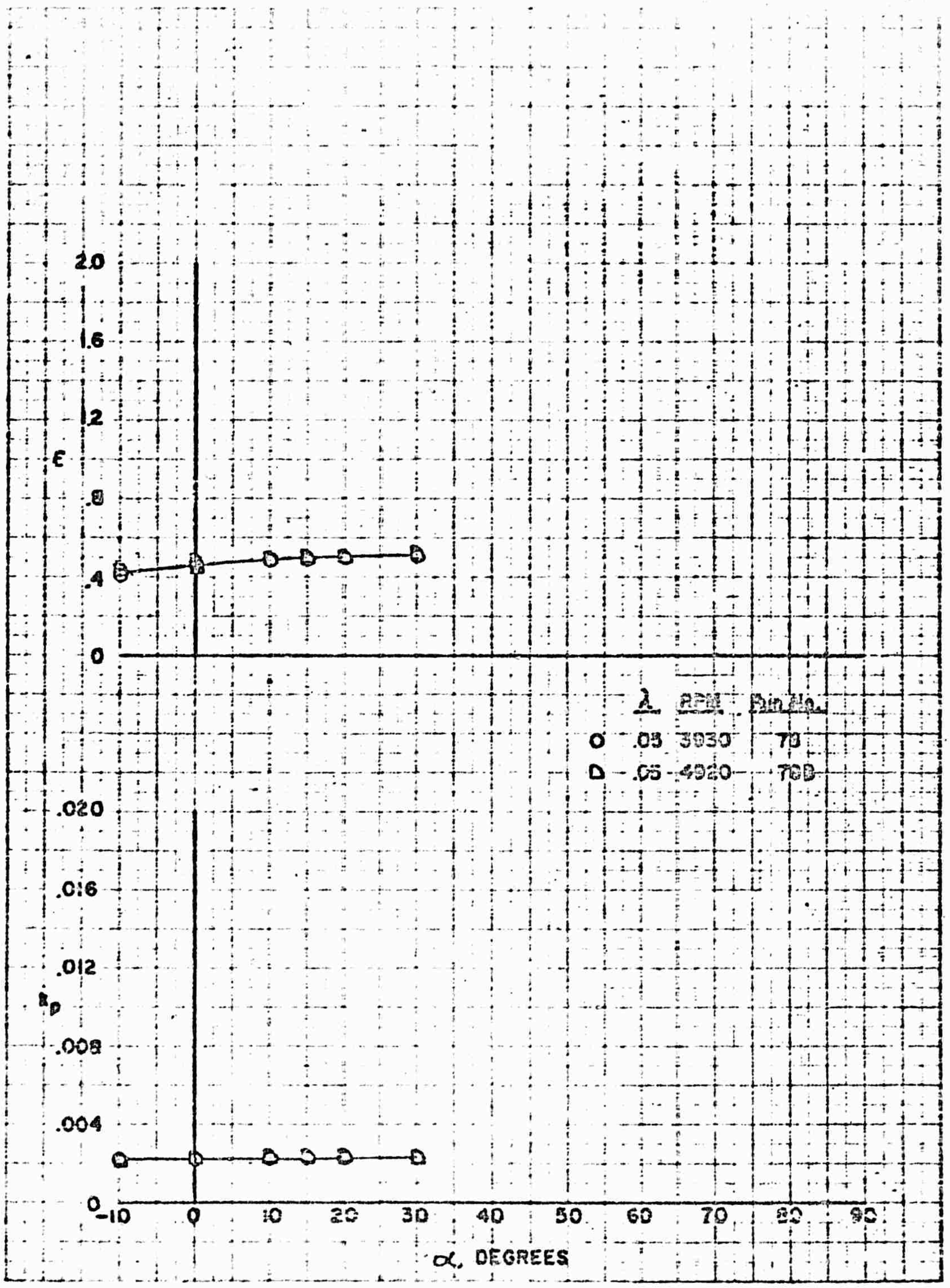

FIGURE 100b VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S

$\beta = 12°$

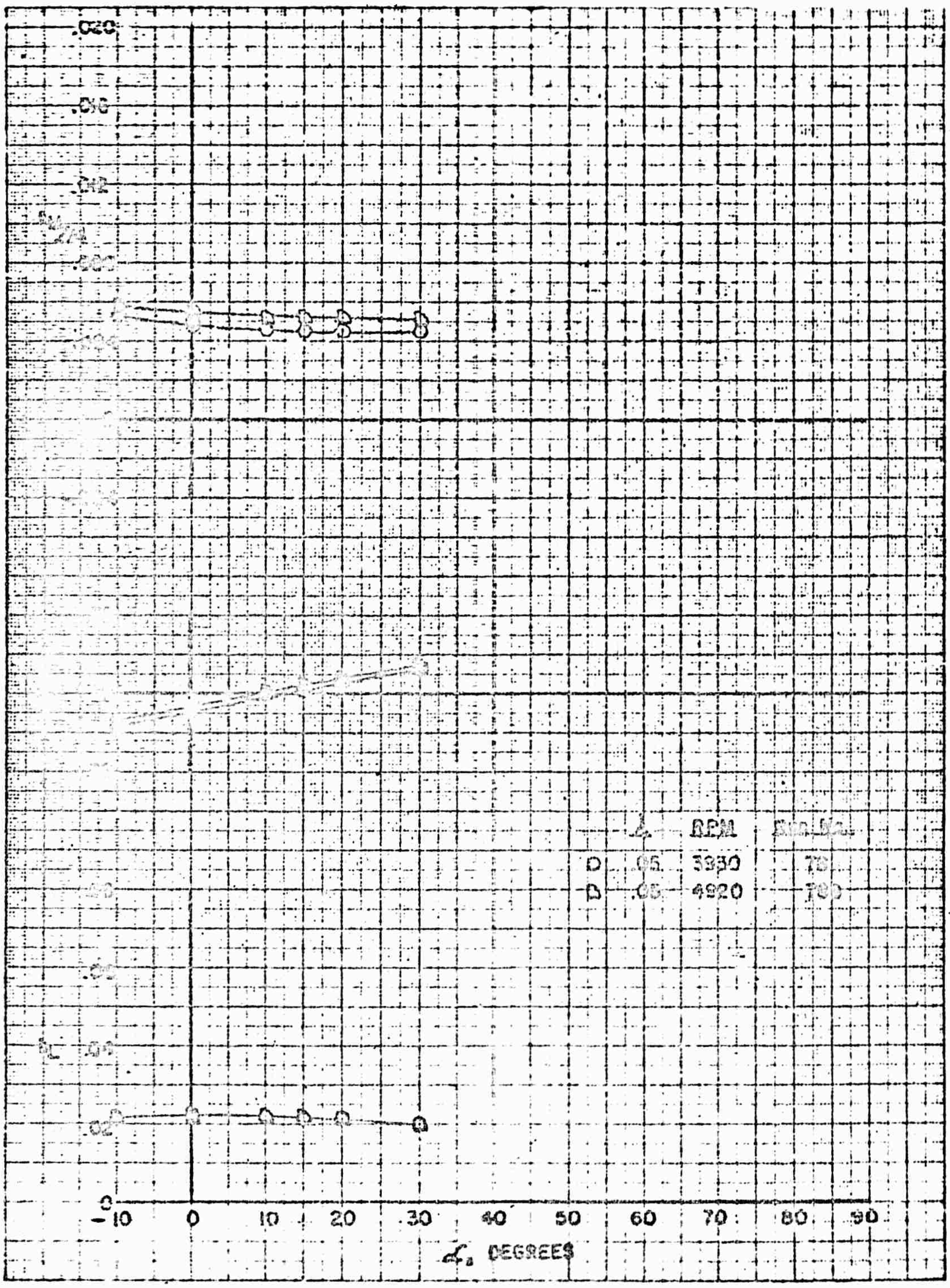

FIGURE 101 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D₁

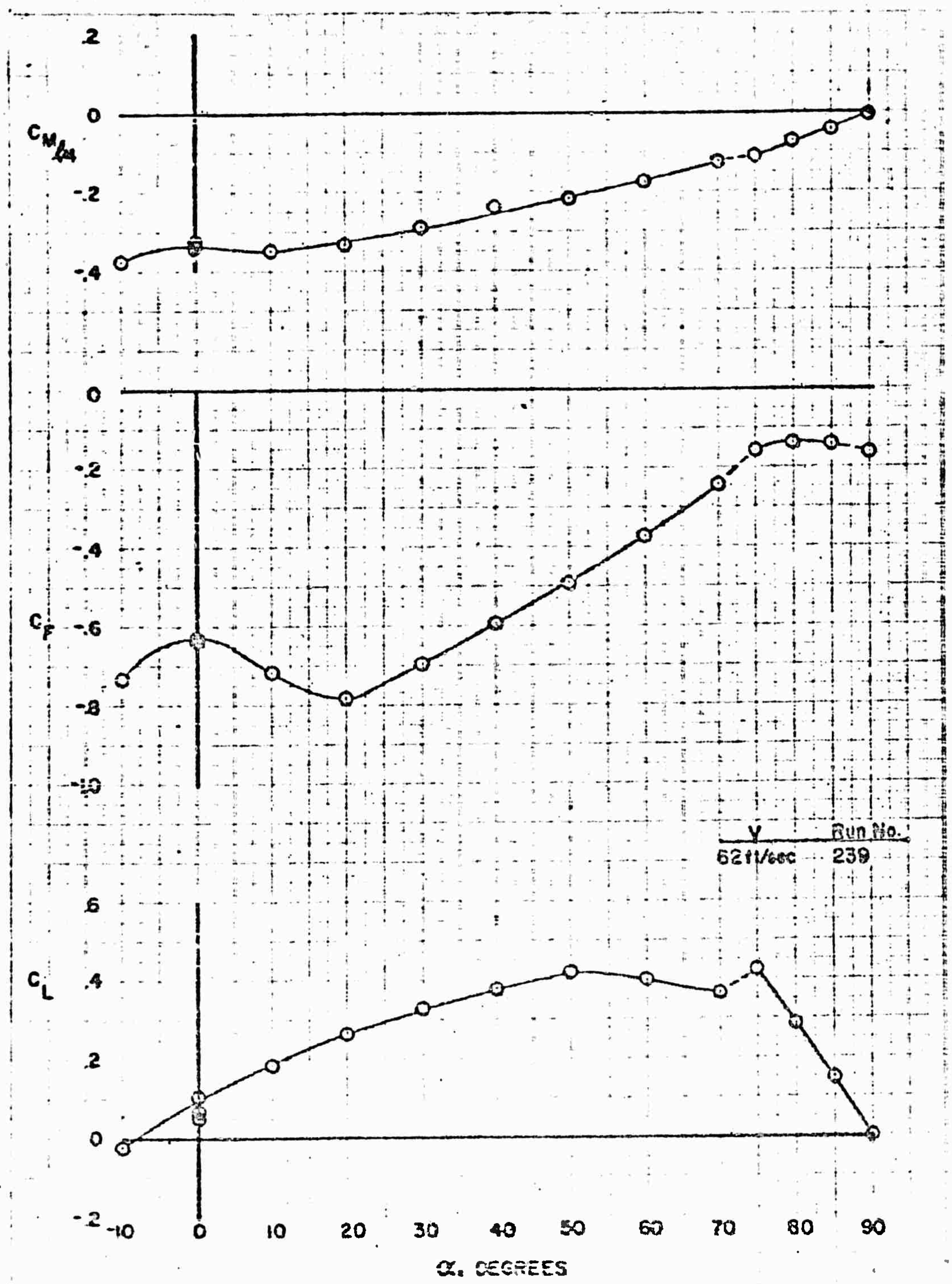

FIGURE 102 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3

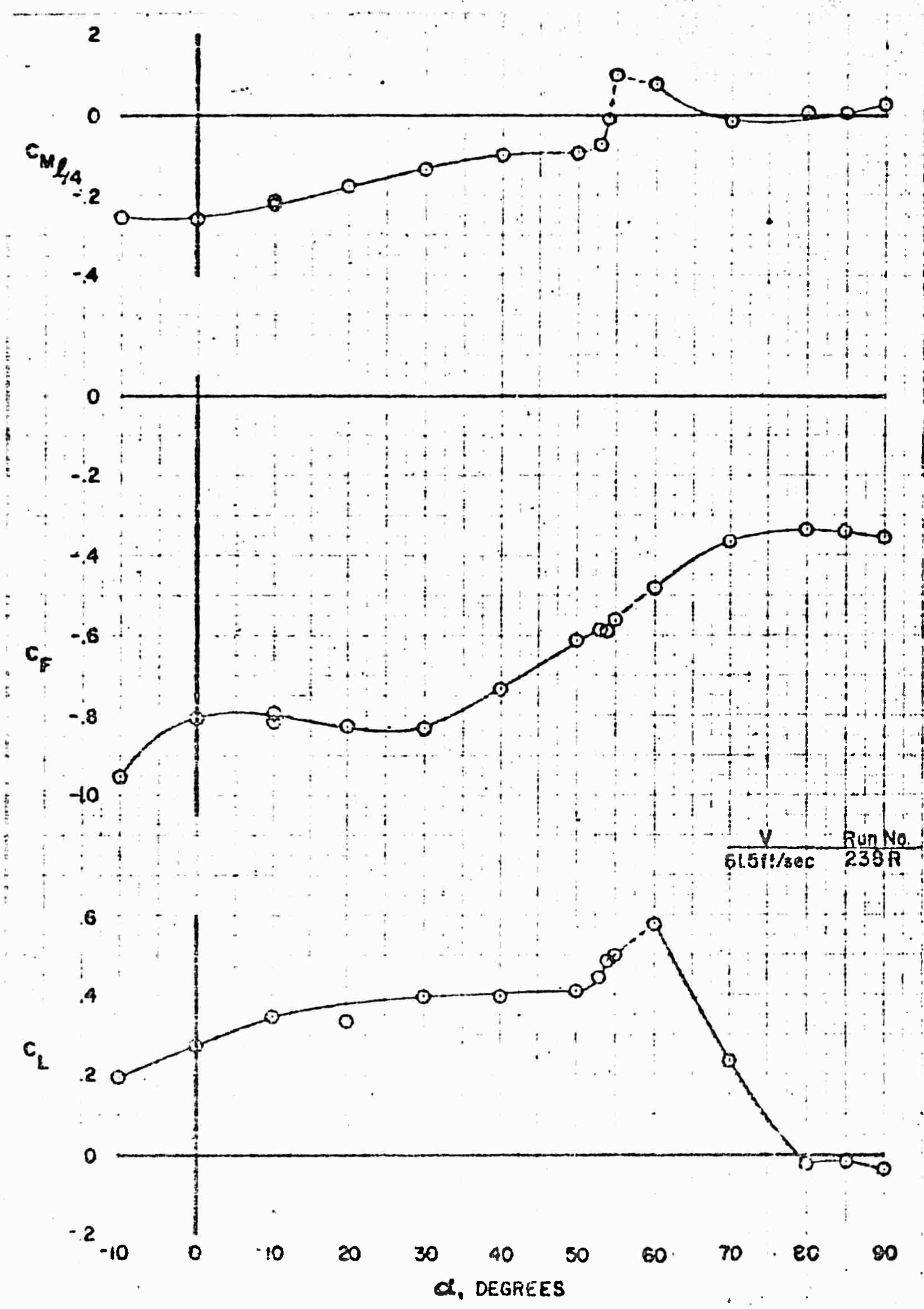

FIGURE 103 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4

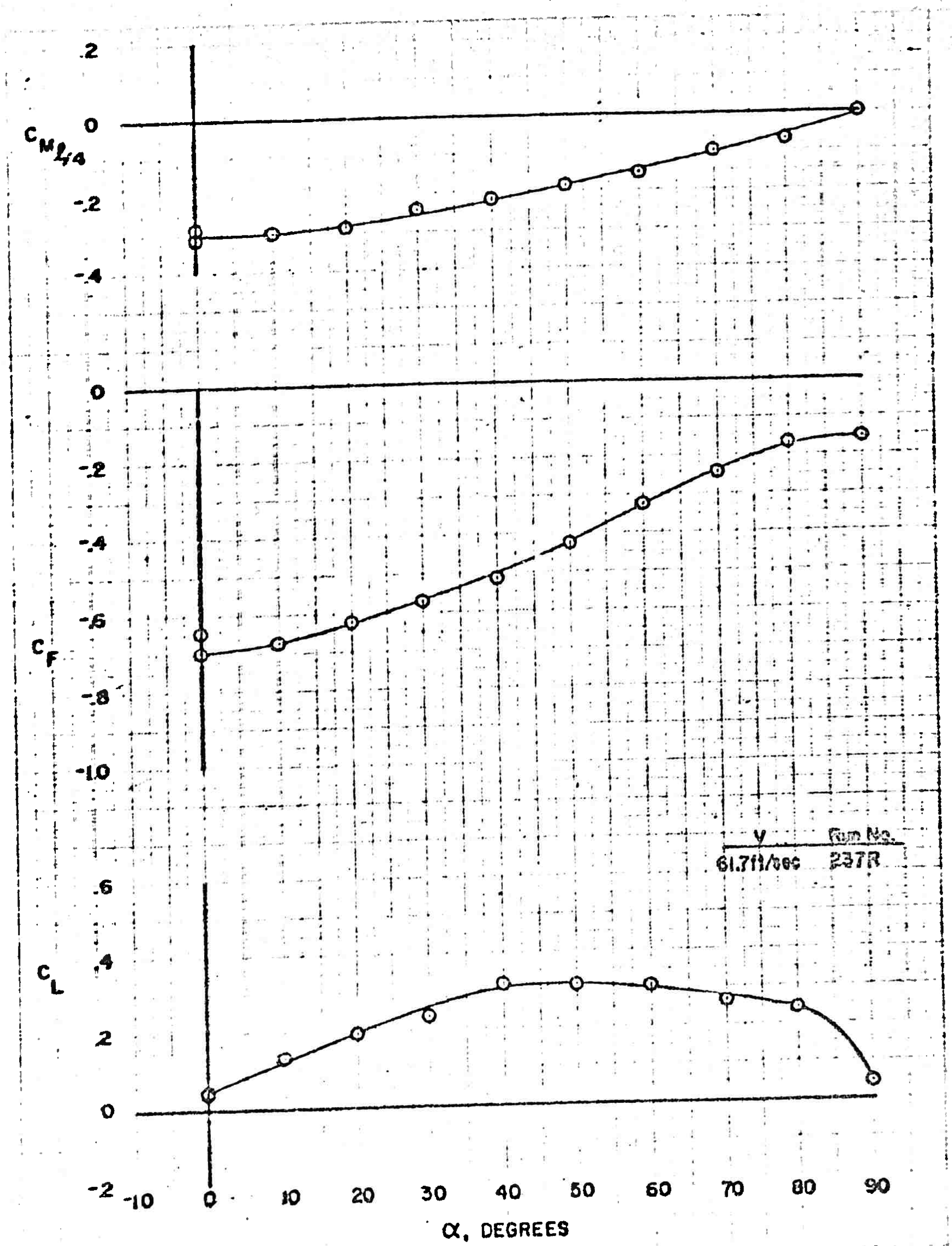

FIGURE 104 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: $D_1 P_3 S$

$\alpha = 10°$

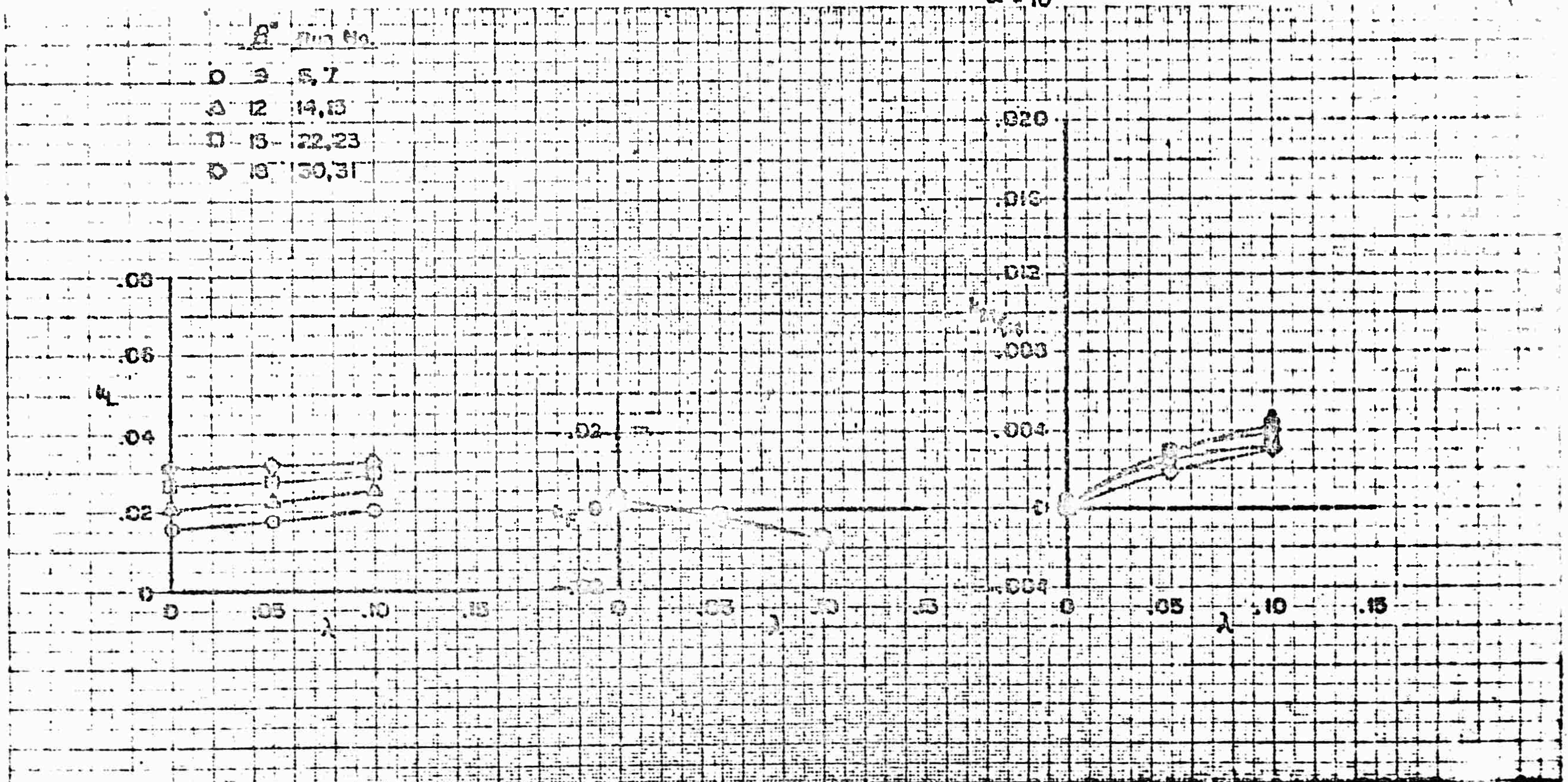

FIGURE 105 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: $D_1 P_3 S$
$\alpha = 20°$

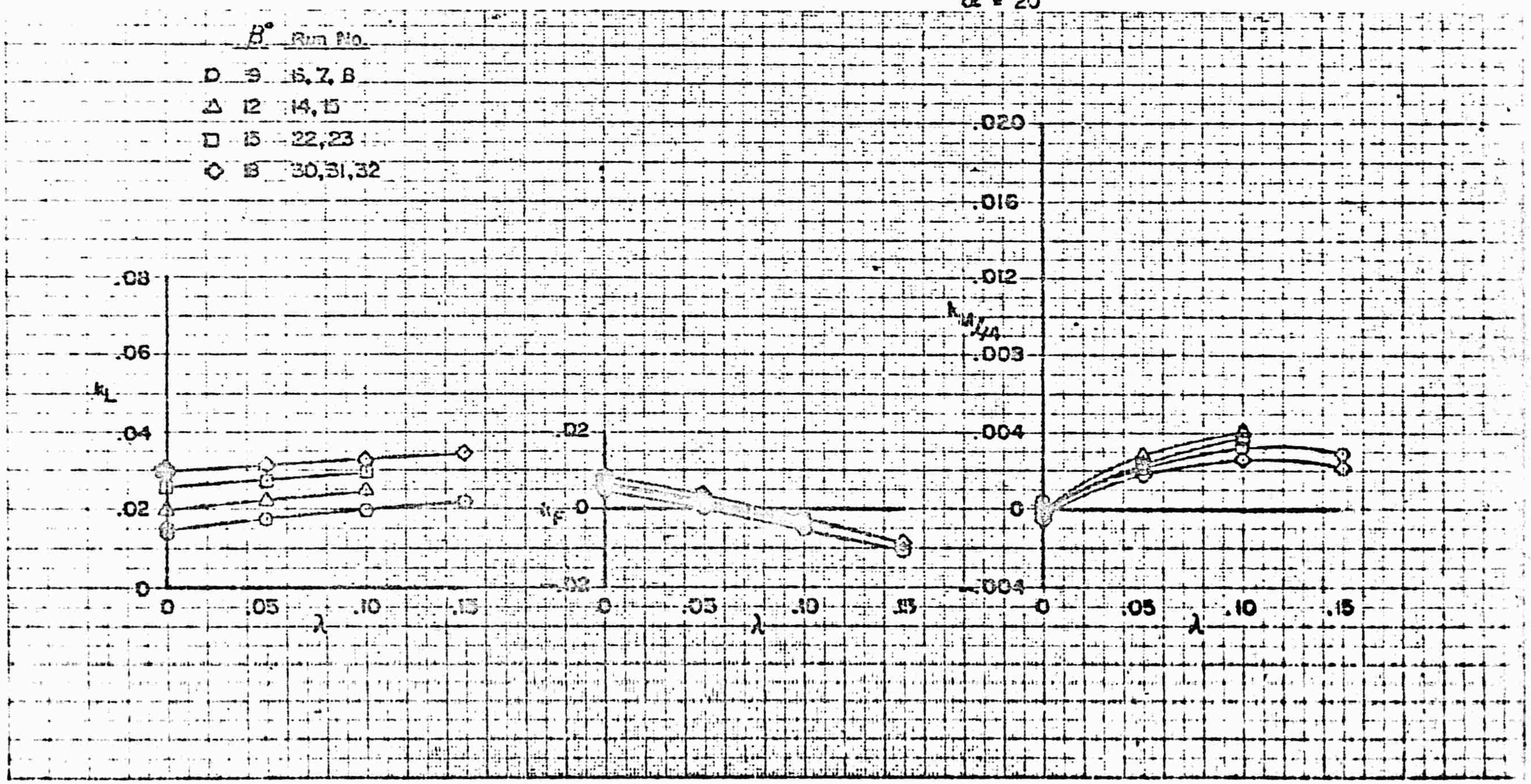

FIGURE 106 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S
$\alpha = 30°$

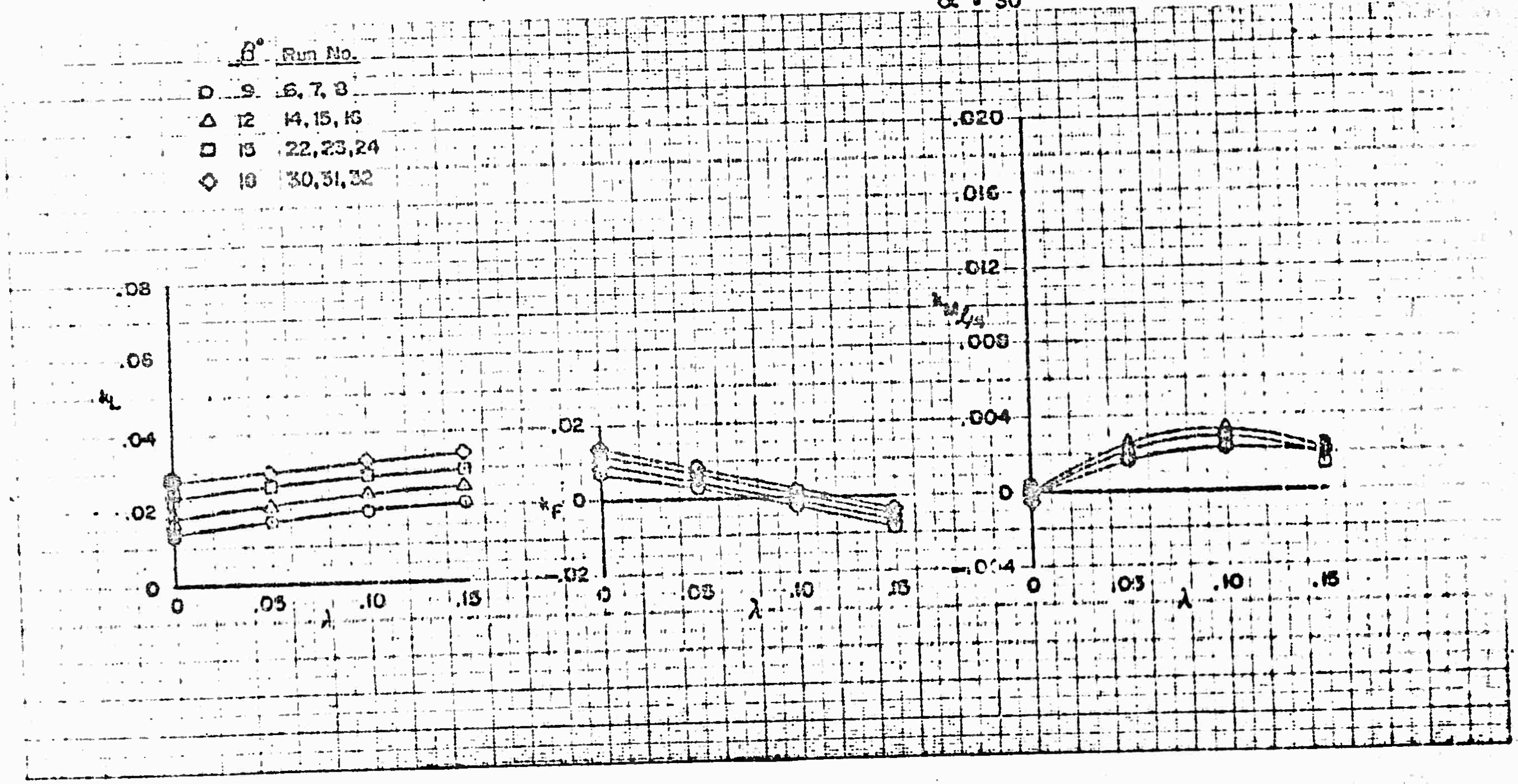

FIGURE 107 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

$\alpha = 40°$

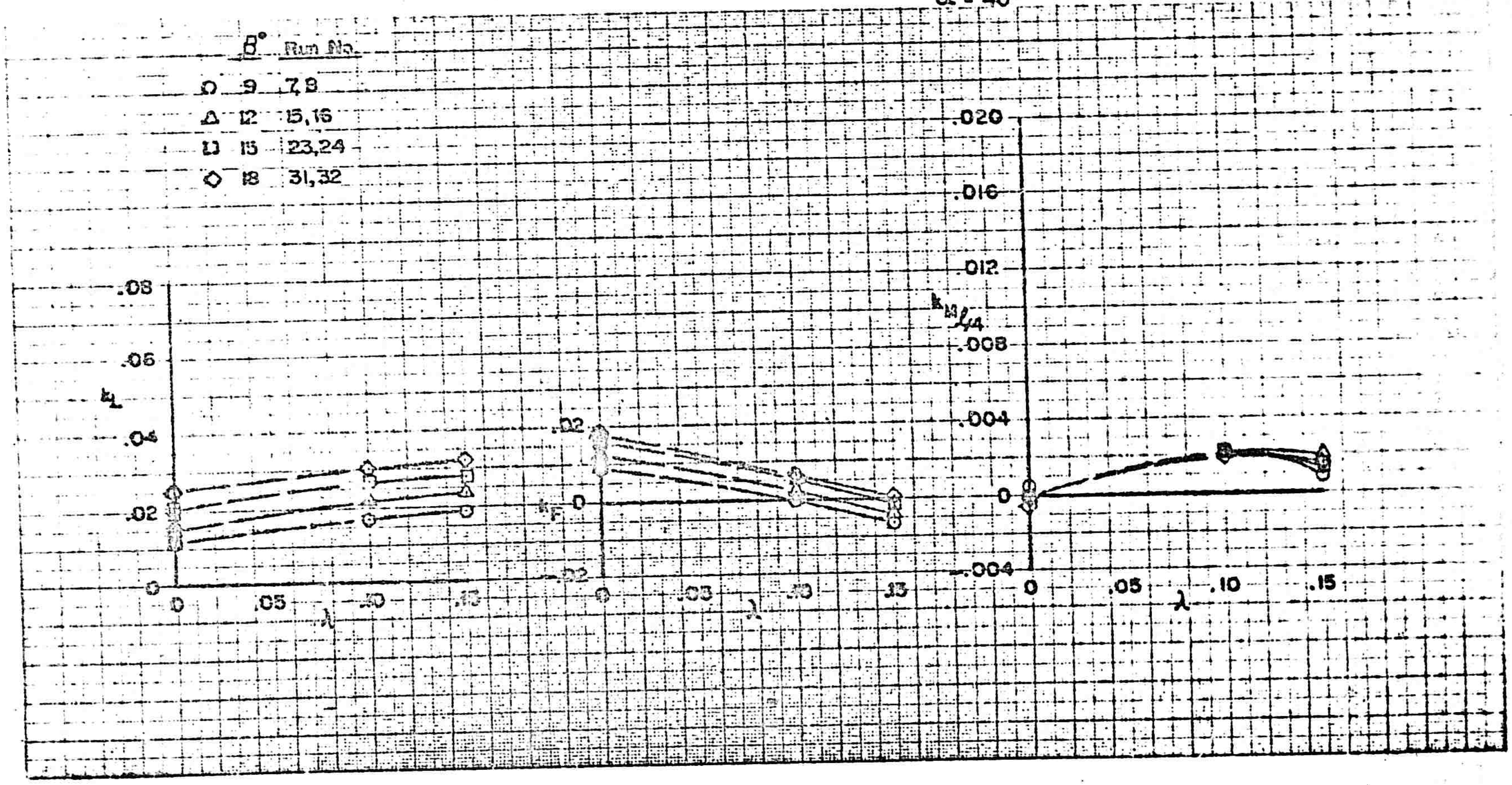

FIGURE 108 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

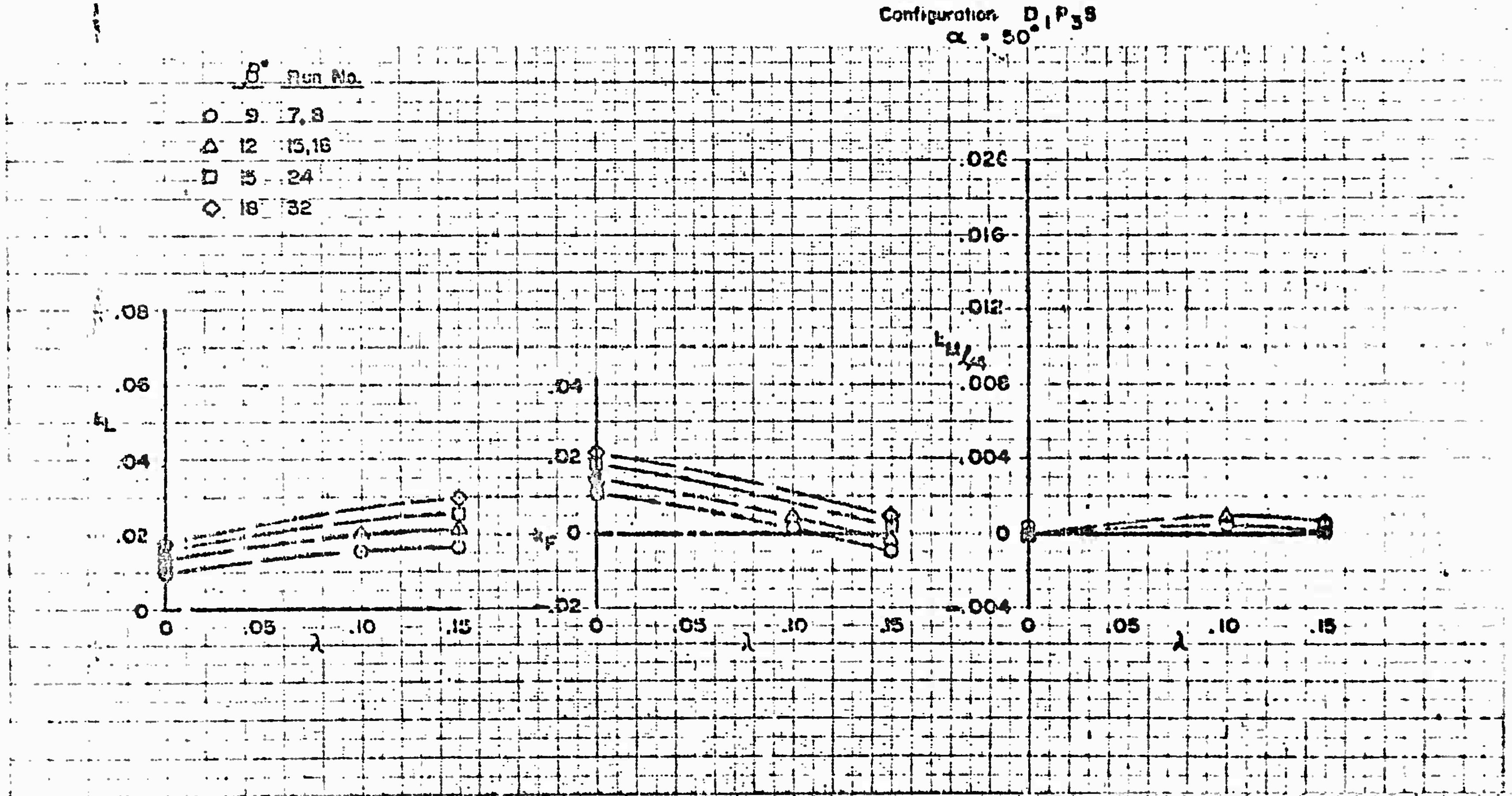

FIGURE 109 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

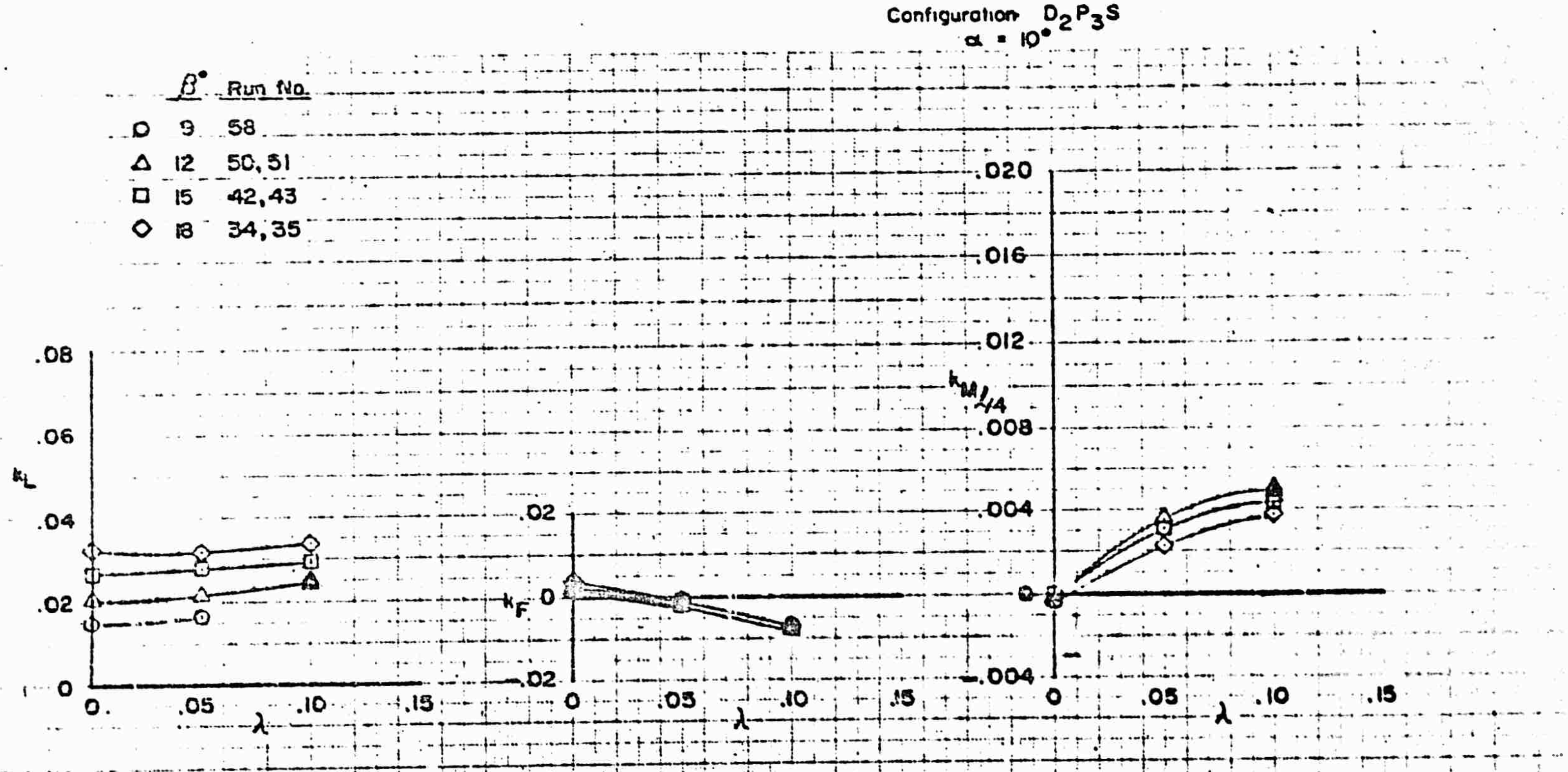

FIGURE 110 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

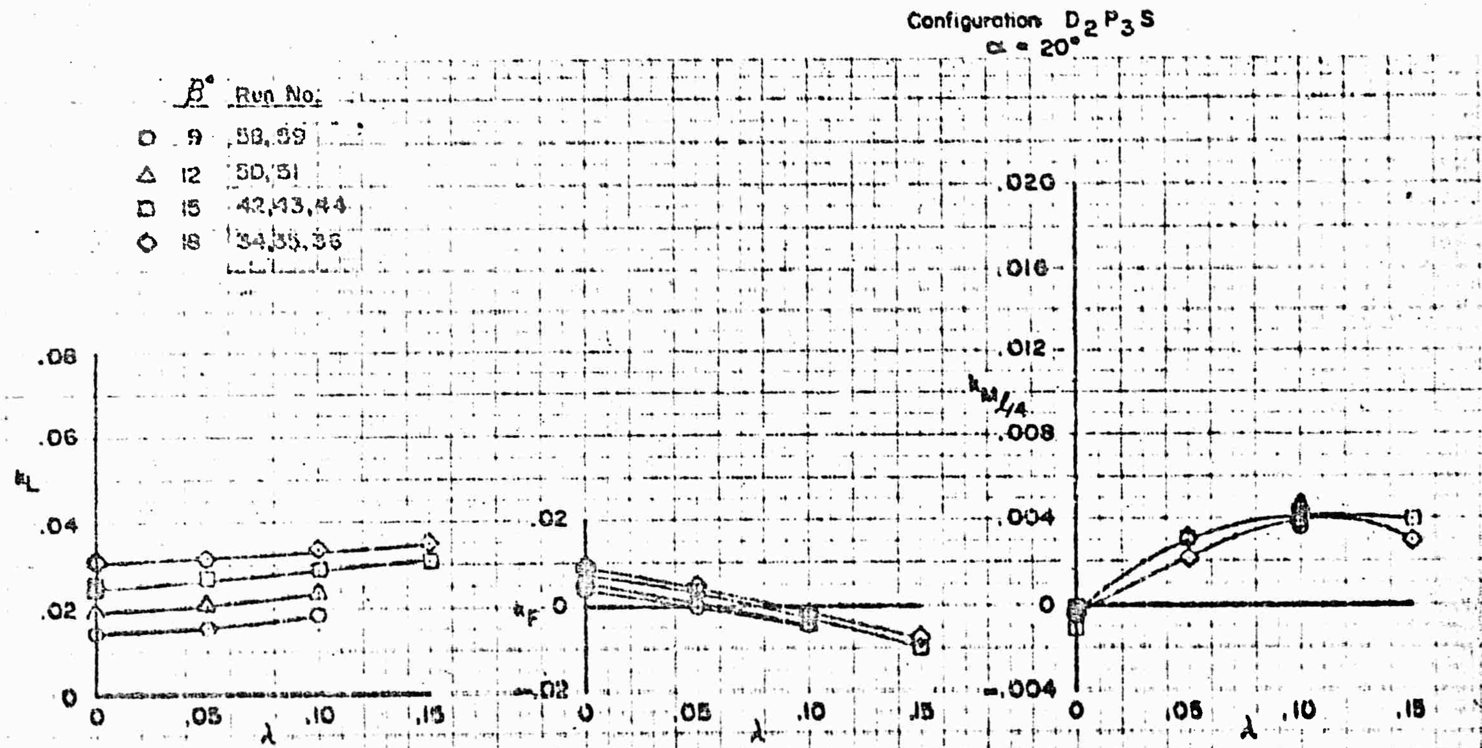

FIGURE 111 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_2P_3S $\alpha = 30°$

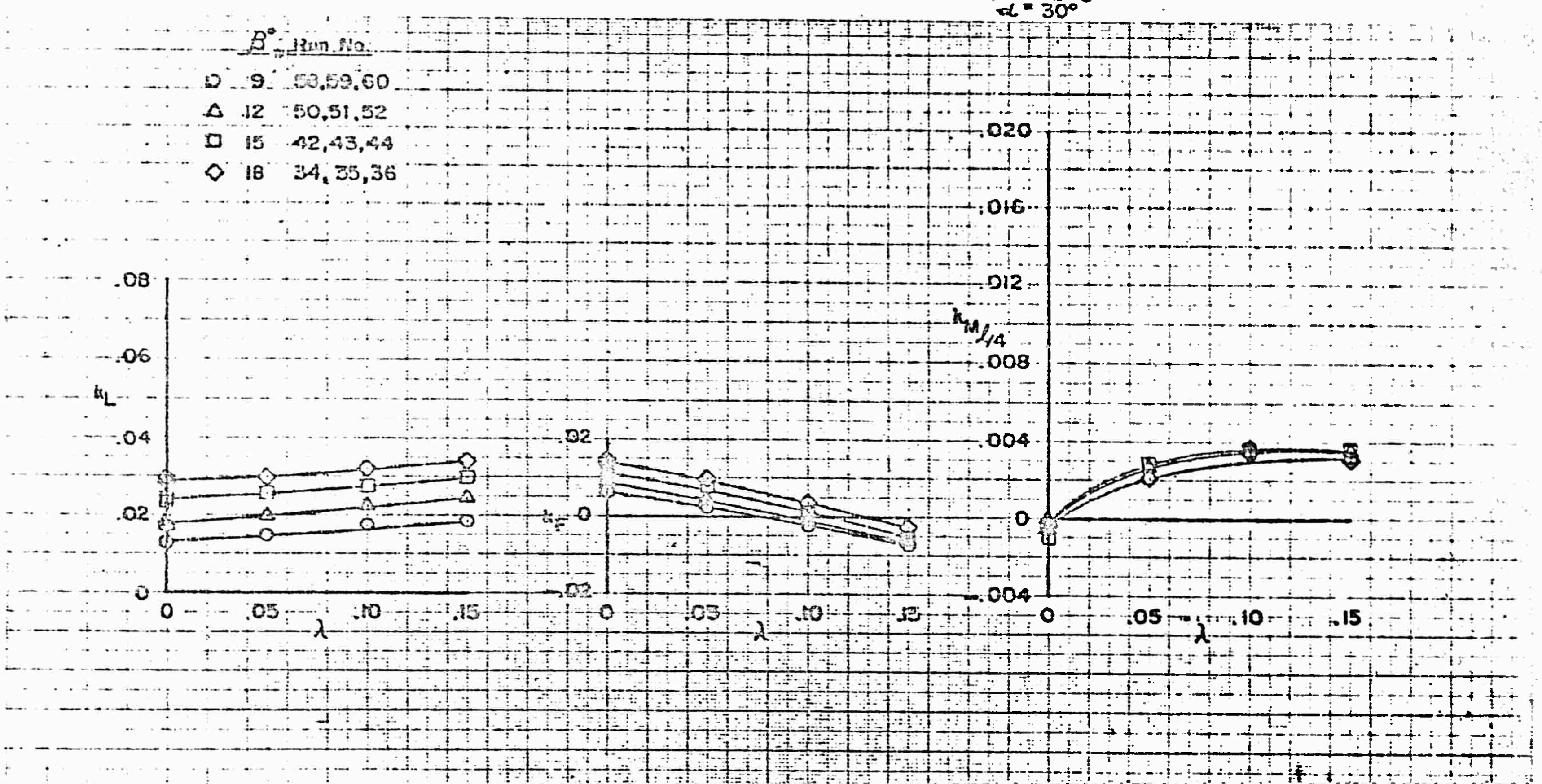

FIGURE 112 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_2P_3S

$\alpha = 40°$

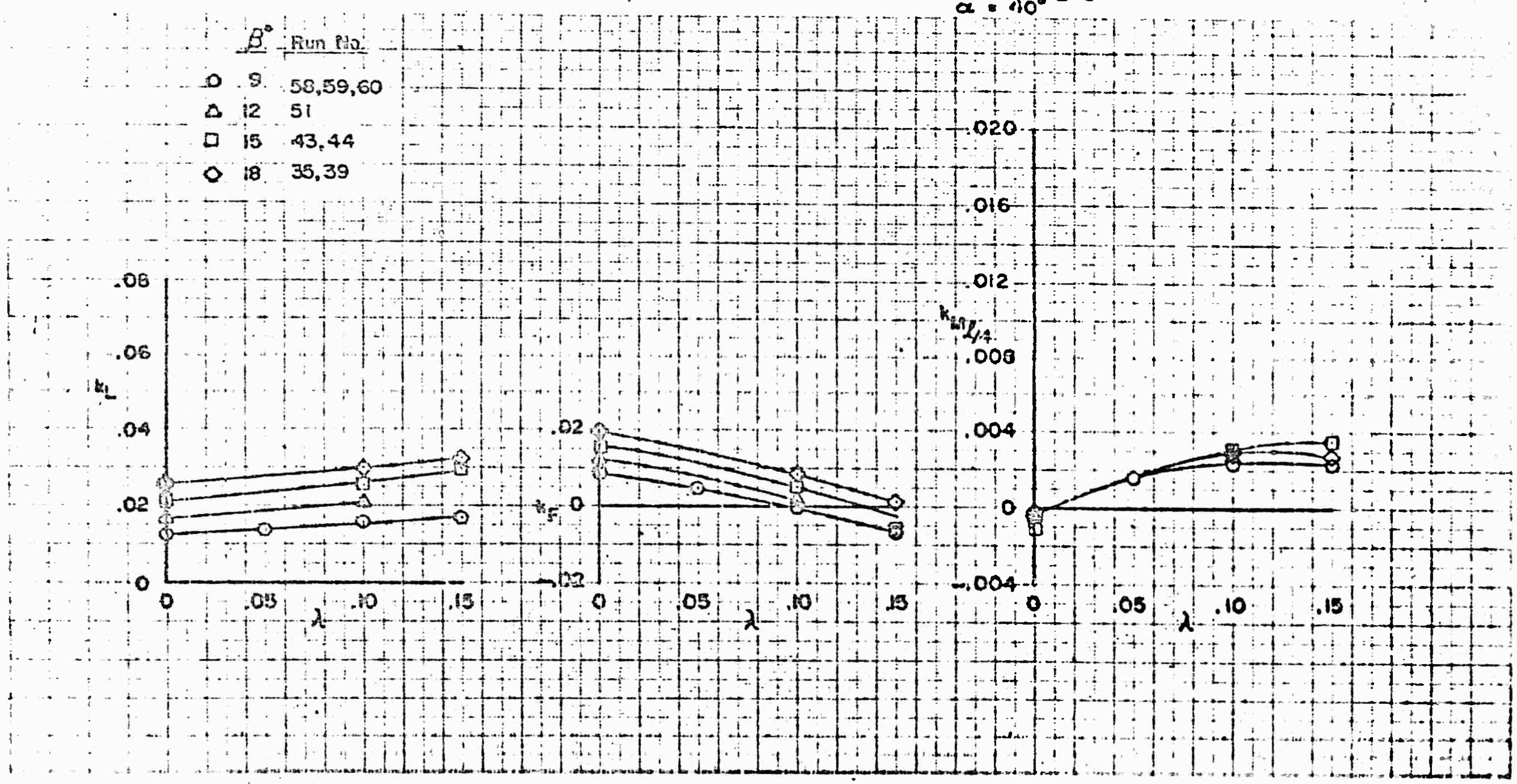

FIGURE 113 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S
α = 10°

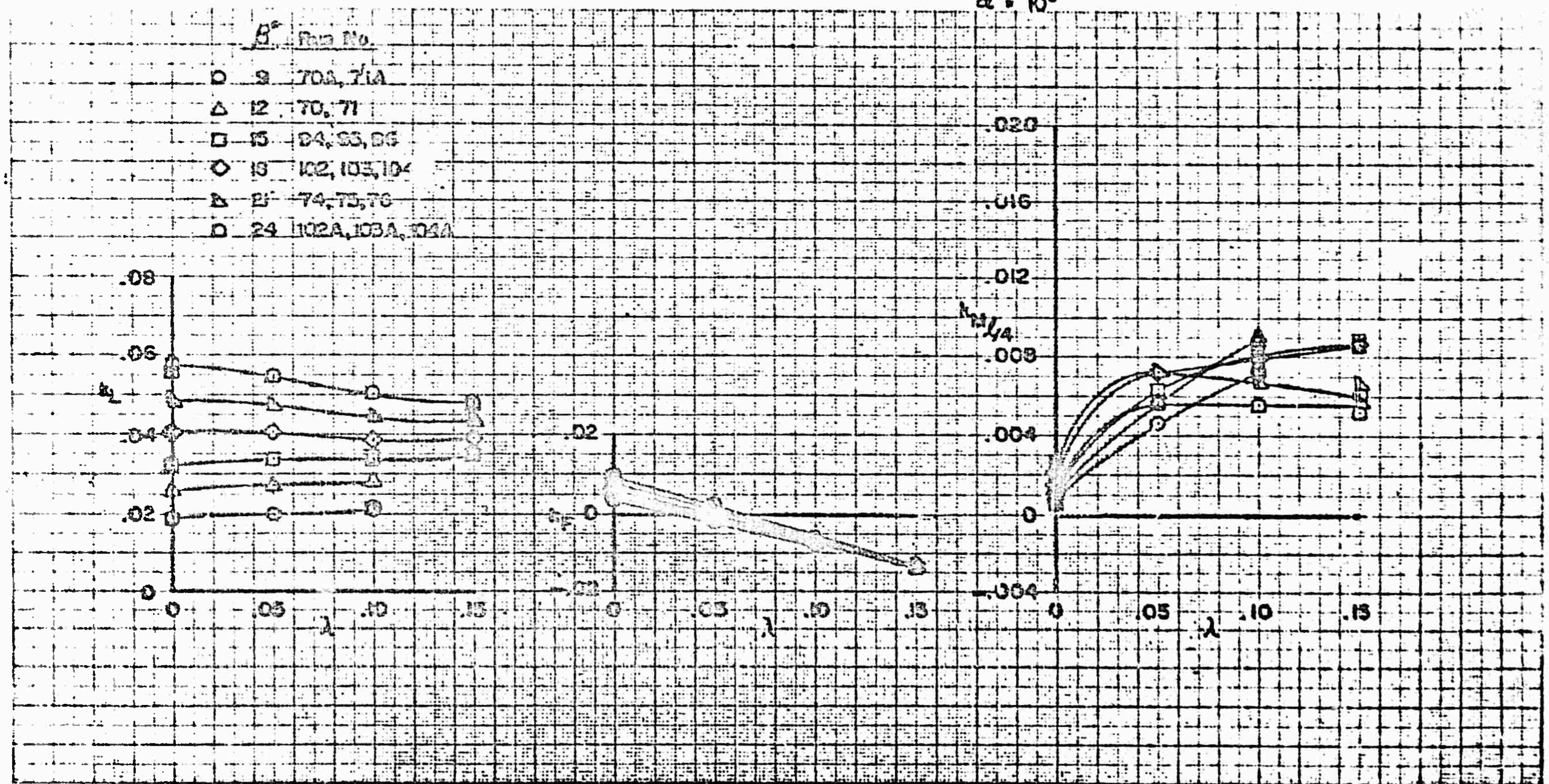

FIGURE 14 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

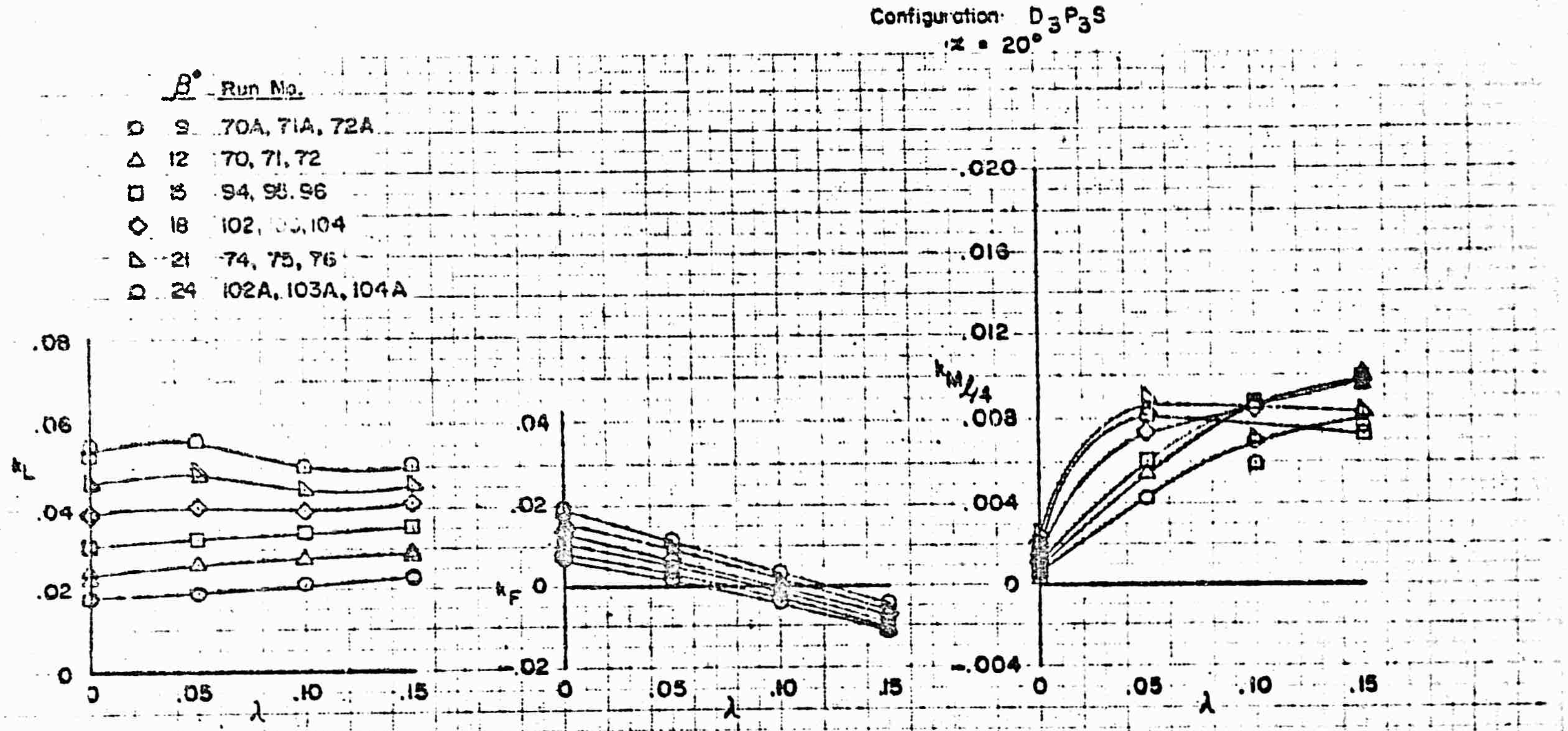

FIGURE 115 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

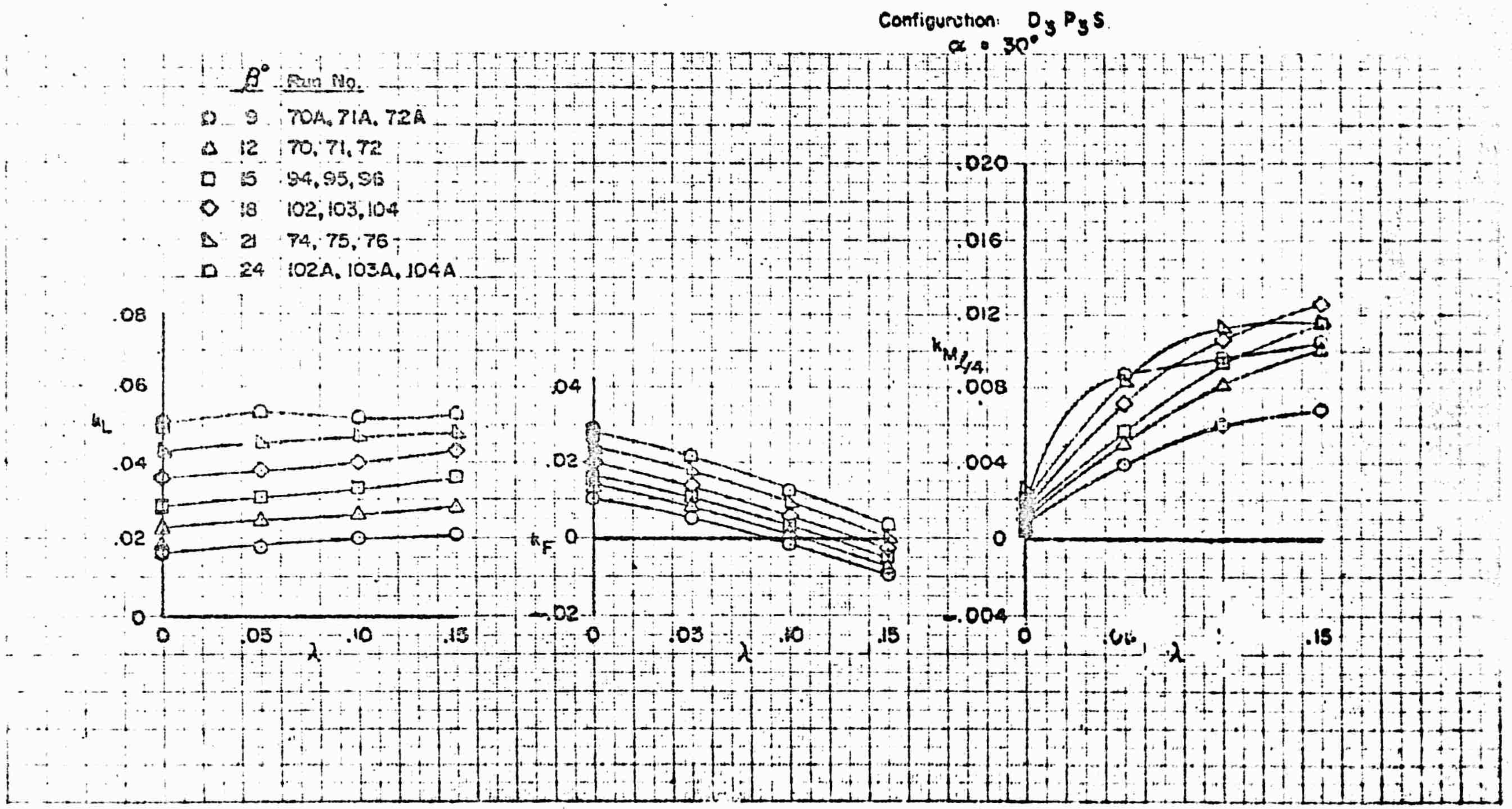

FIGURE 116 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

$\alpha = 40°$

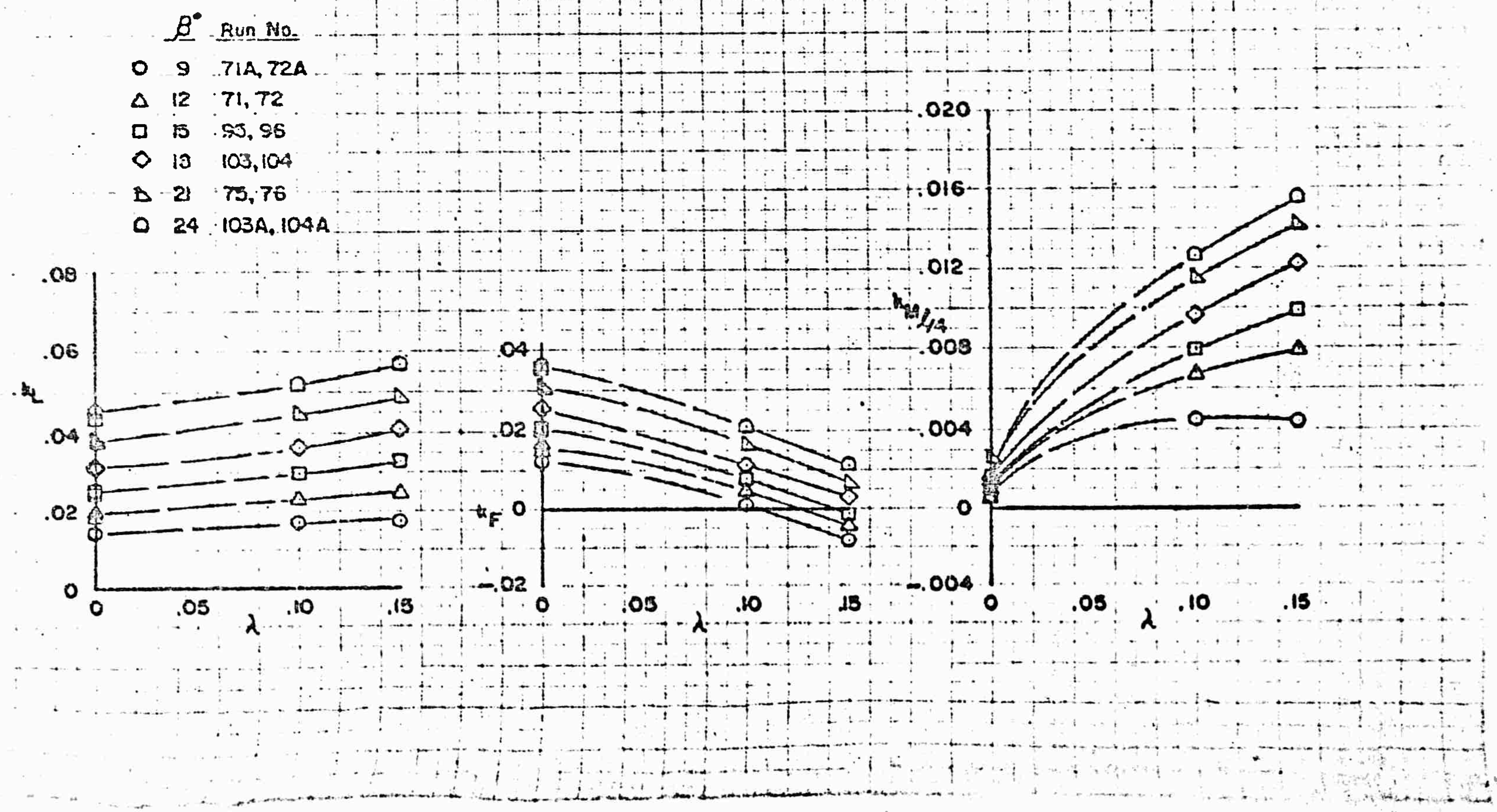

FIGURE 117 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO.

Contract Nonr 1357 (00) Phase IV

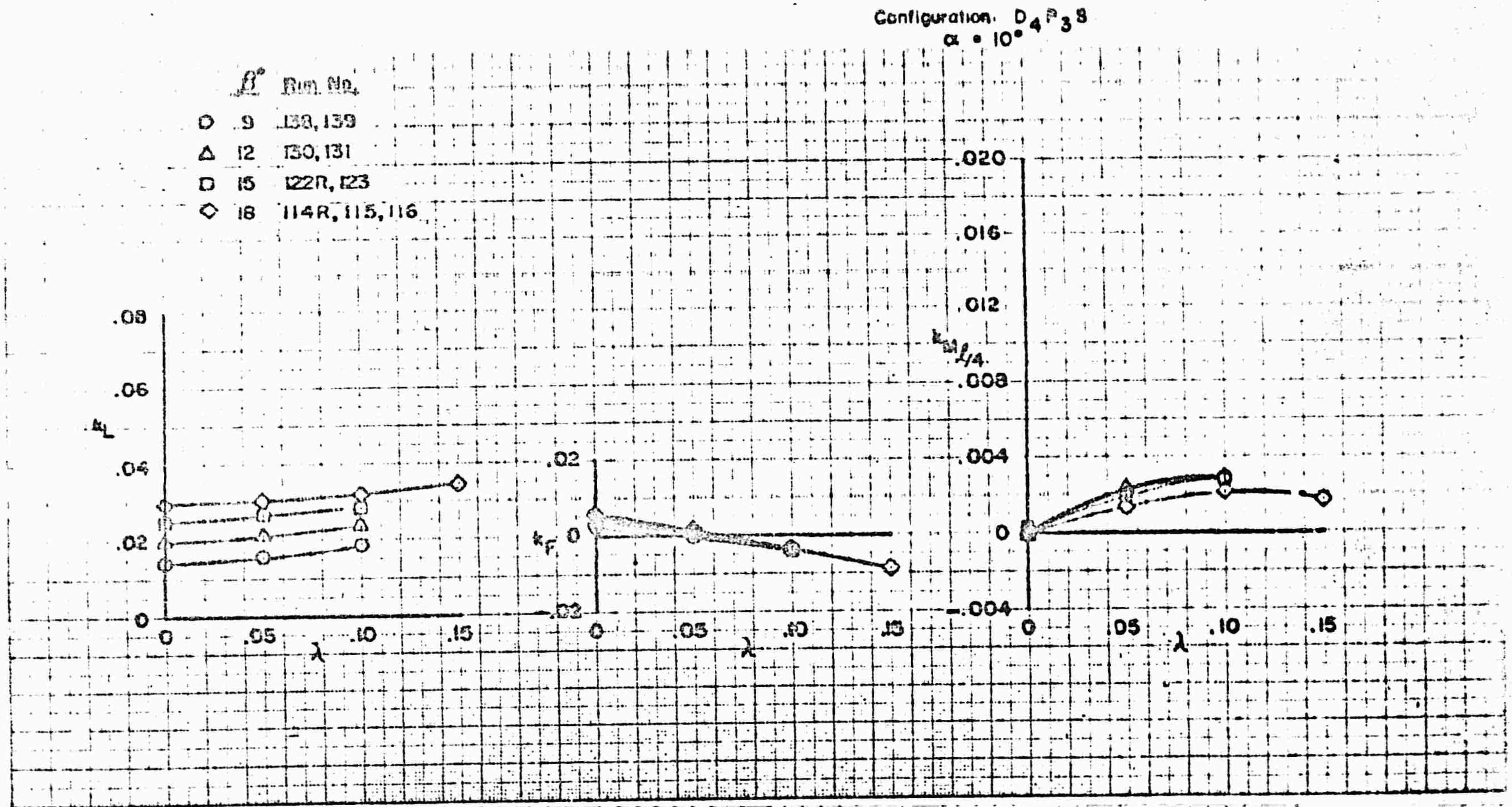

FIGURE 118 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration $D_4 P_3 S$

$\alpha = 20°$

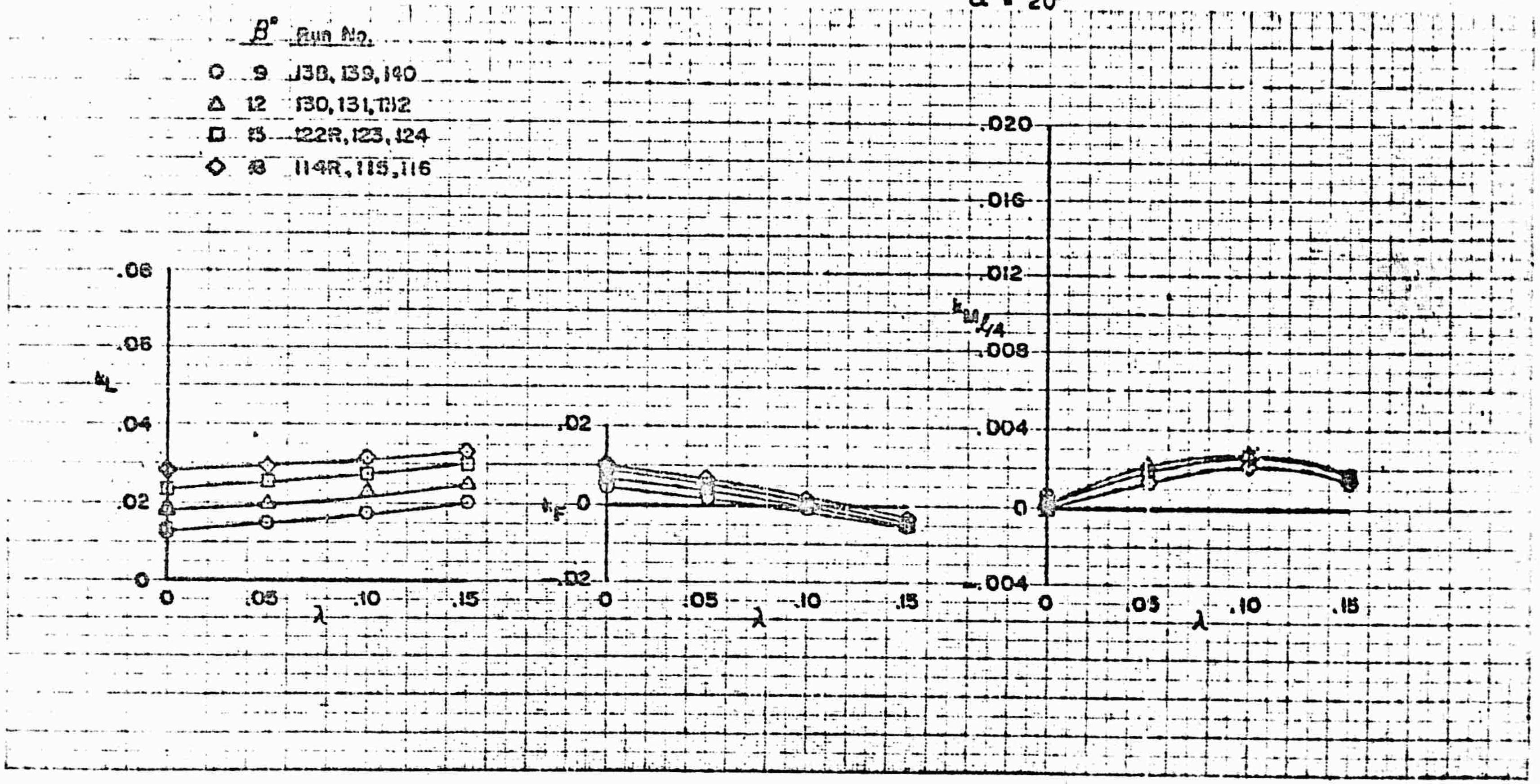

FIGURE 119 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

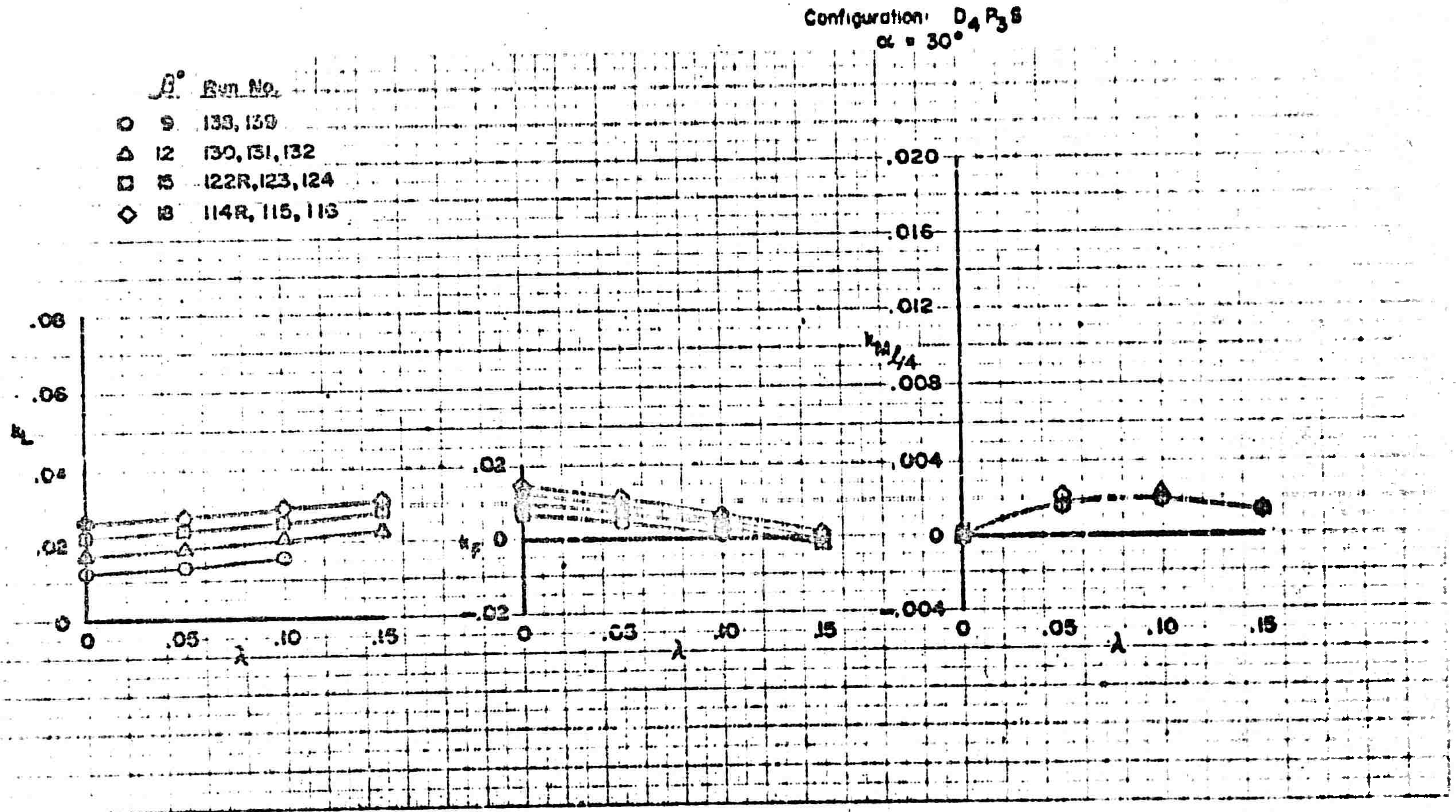

FIGURE 120 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

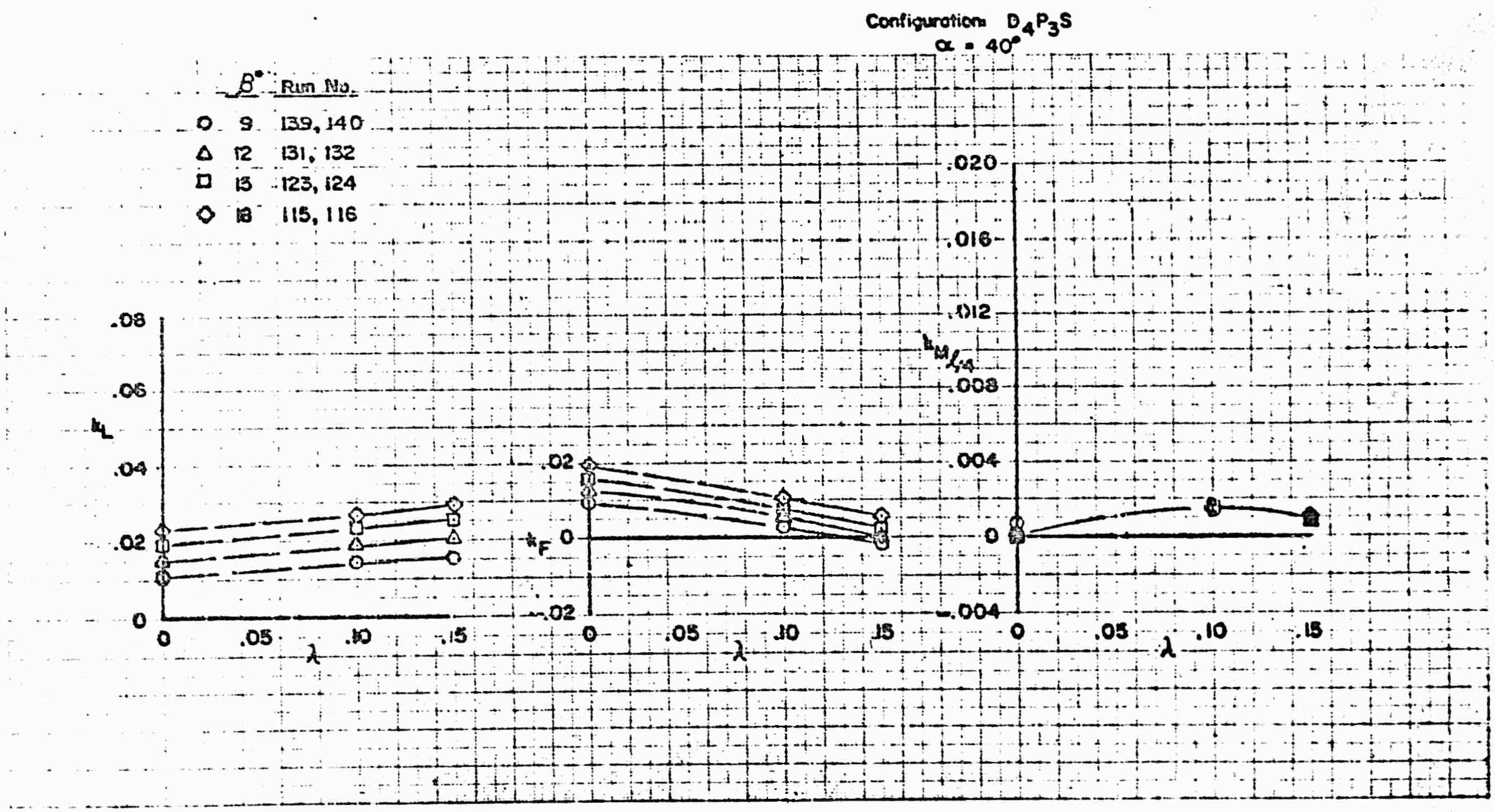

FIGURE 121 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

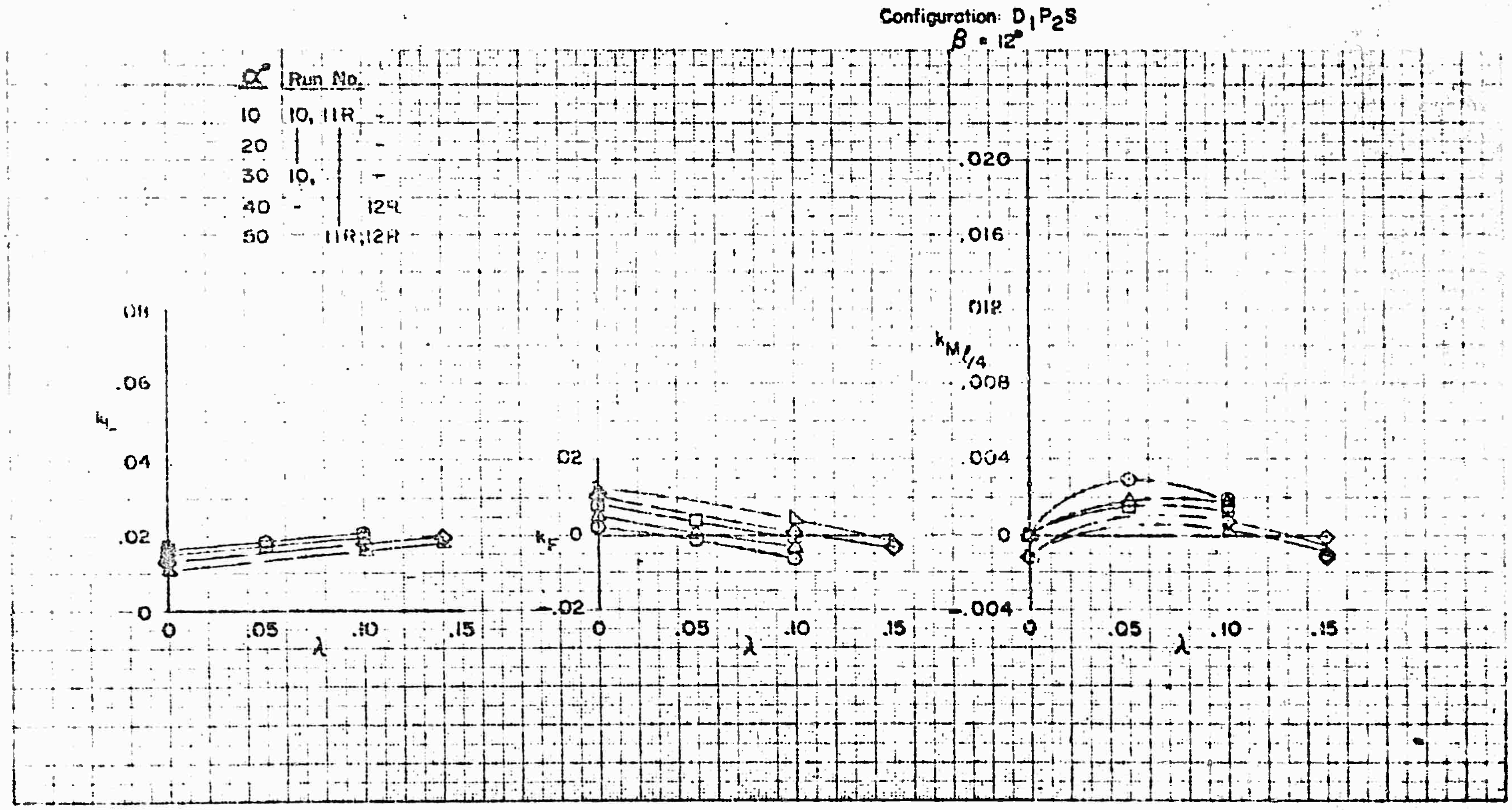

FIGURE 122 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

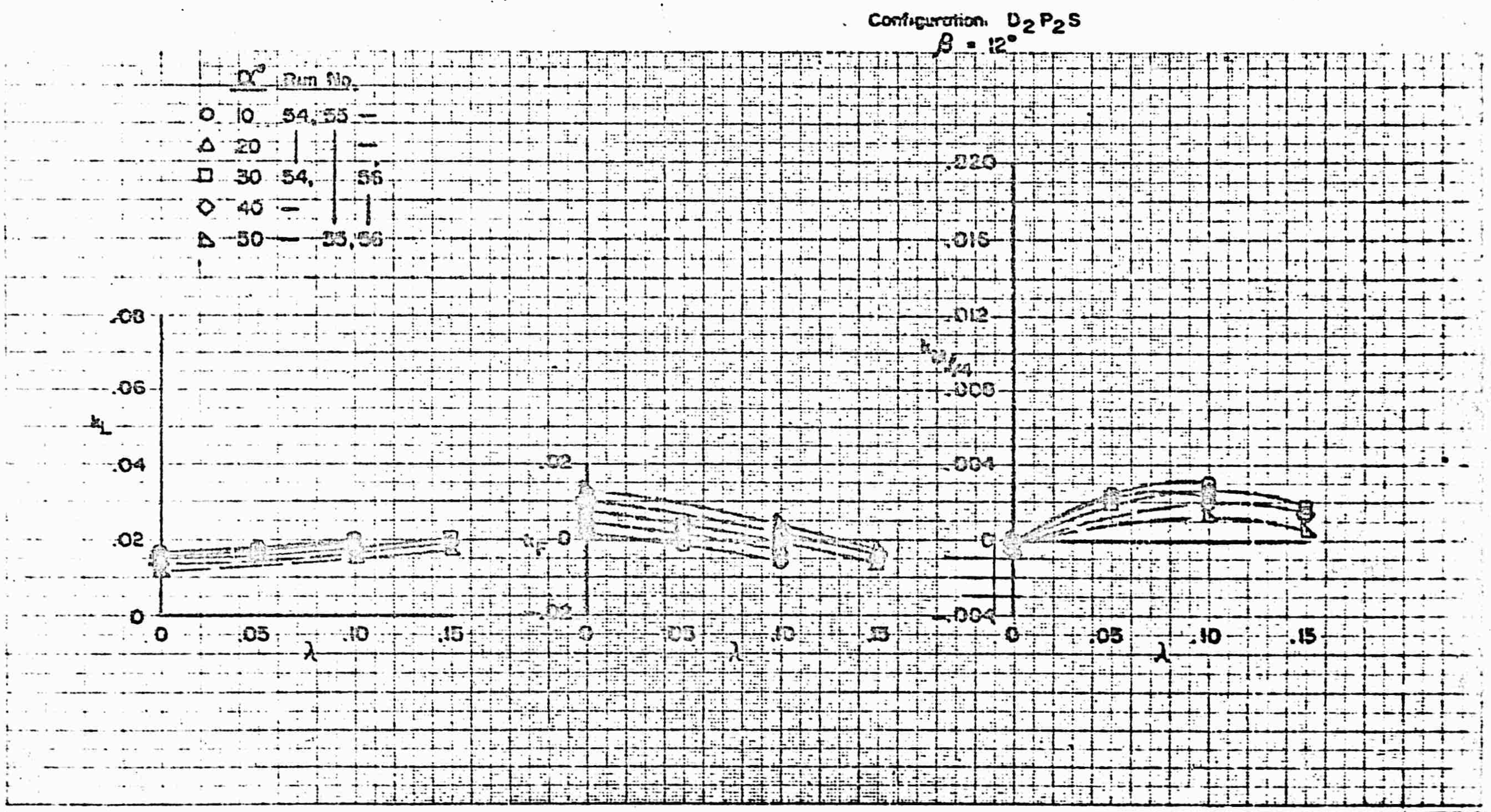

FIGURE 123 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

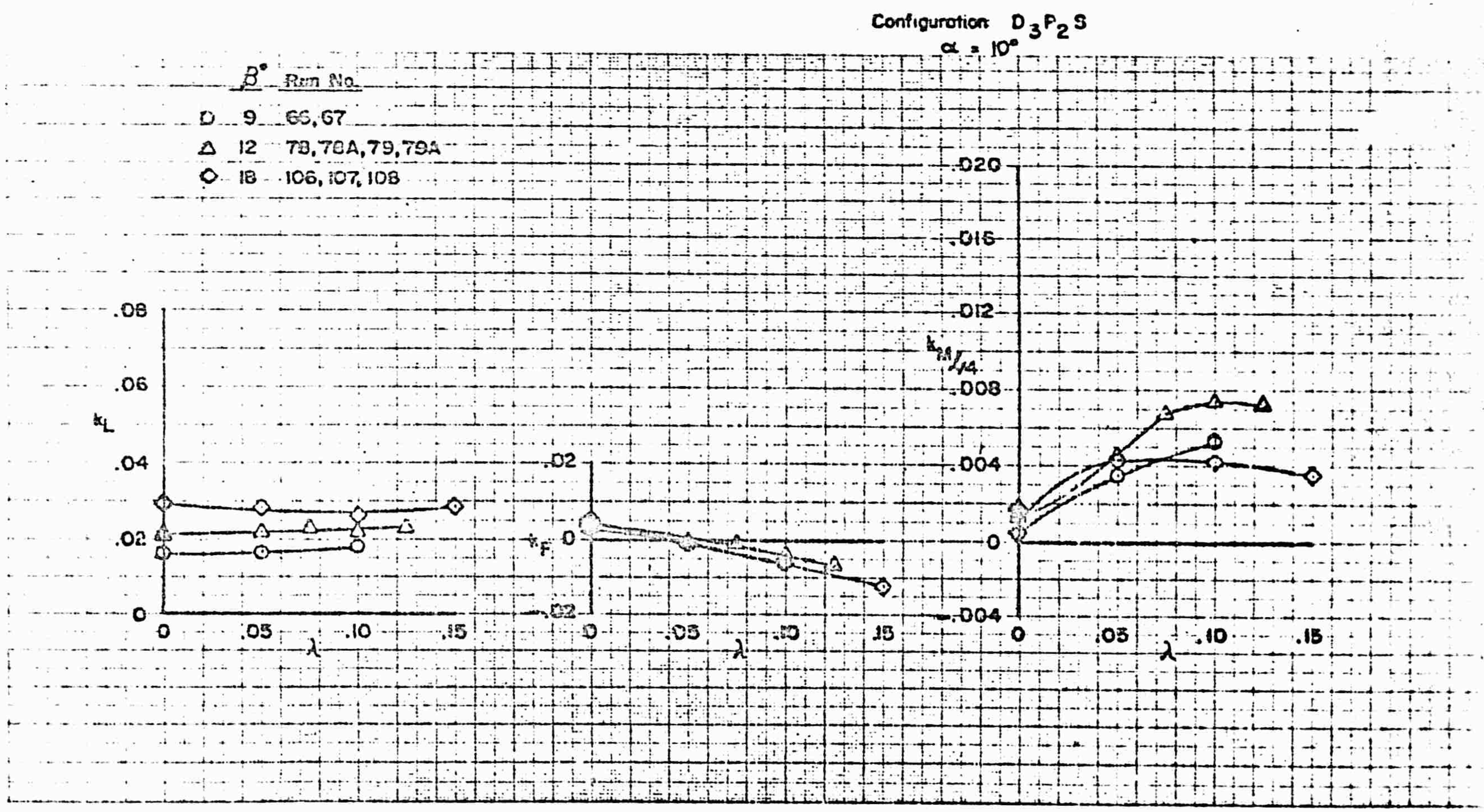

FIGURE 124 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S

$\alpha = 20°$

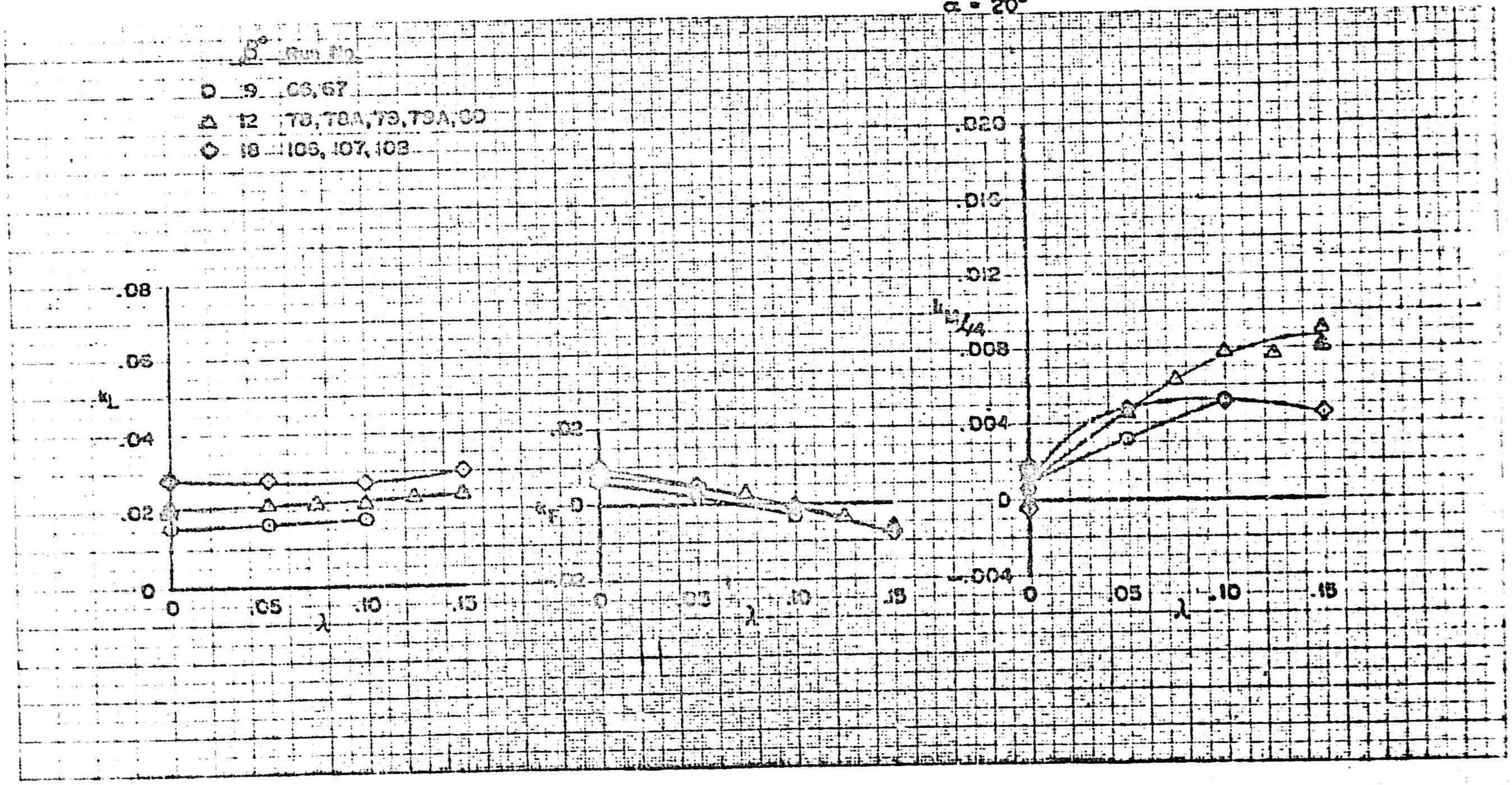

FIGURE 125 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

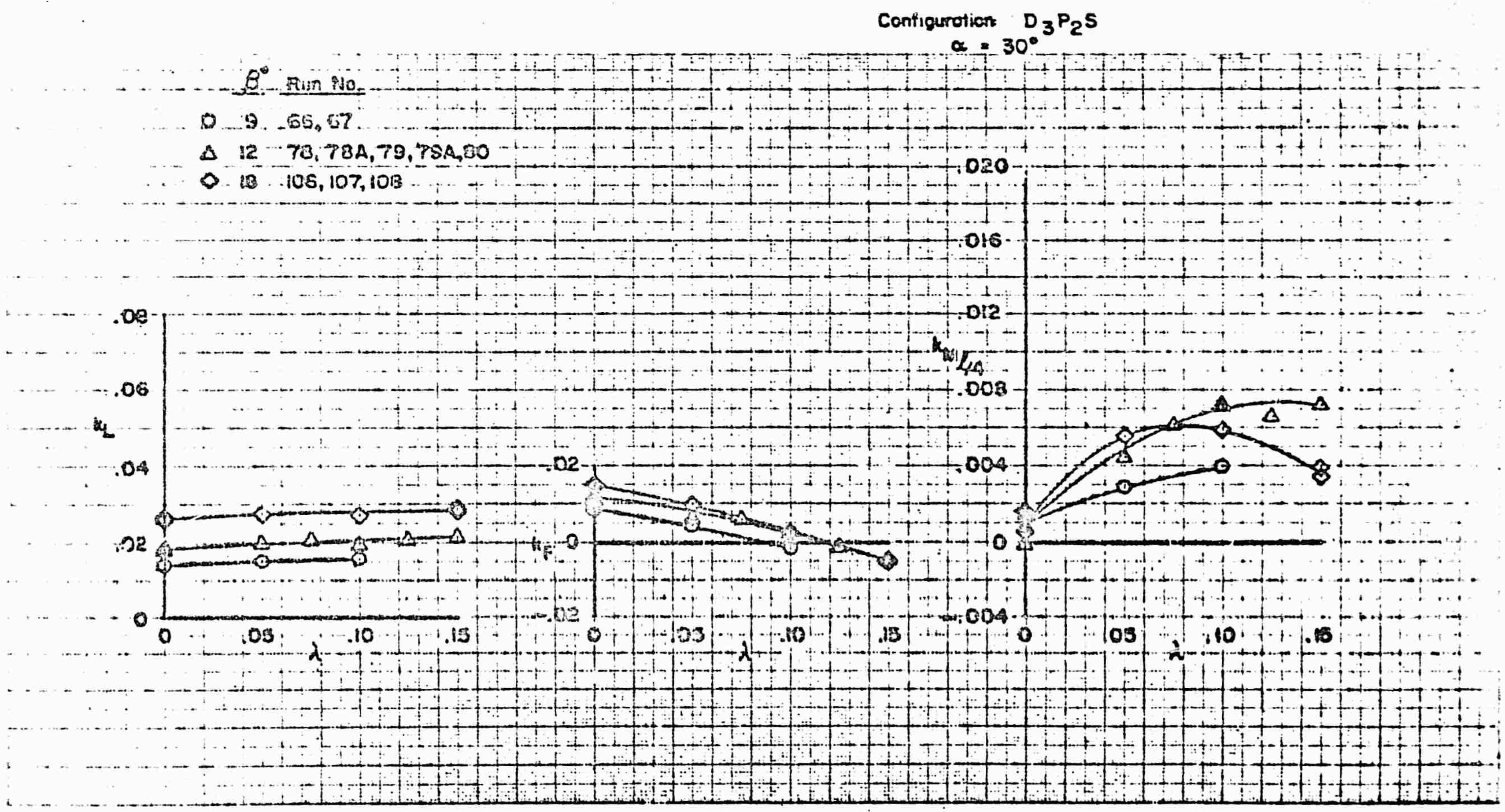

FIGURE 126 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

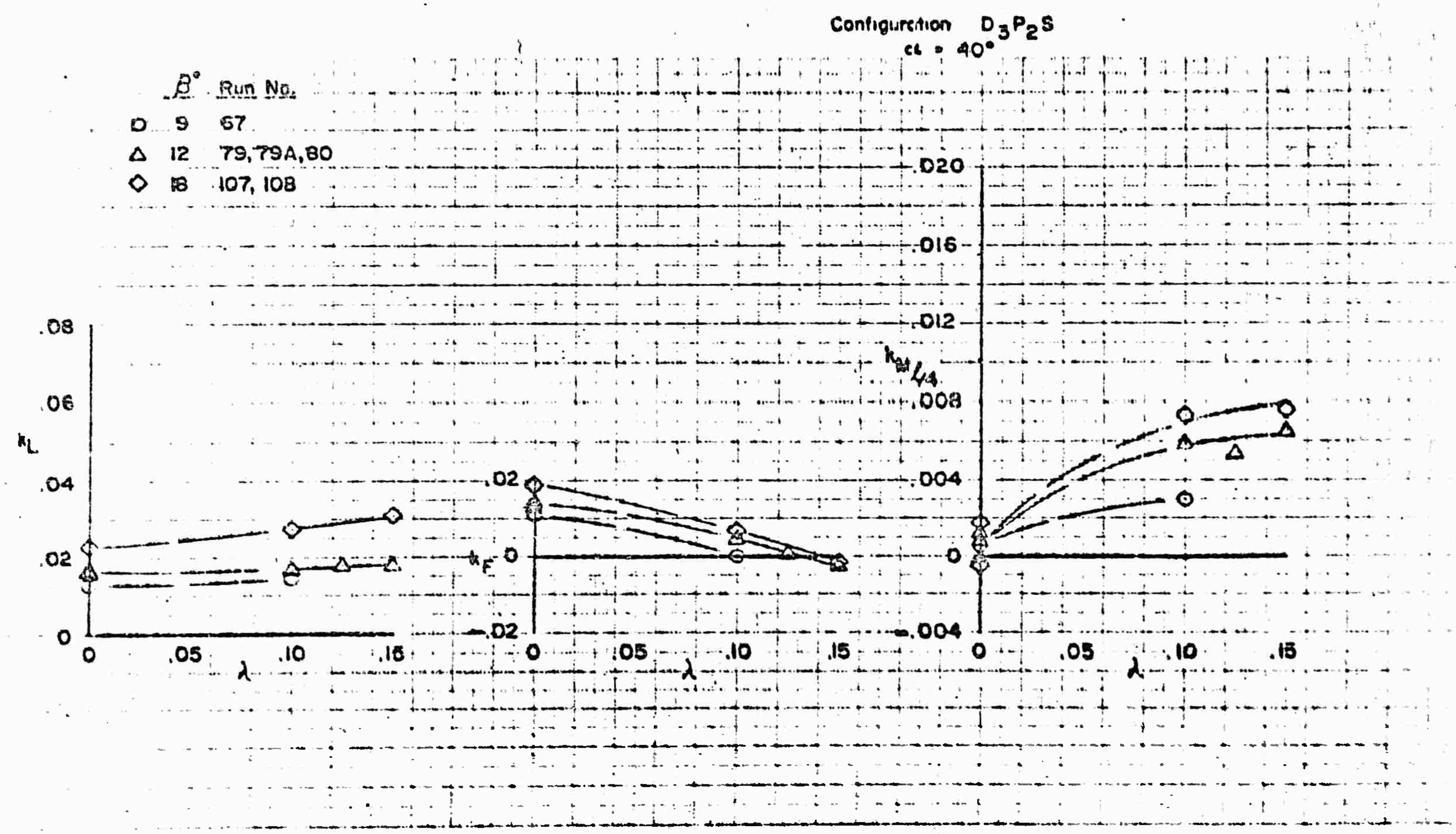

FIGURE 127 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_4P_2S
$\beta = 12°$

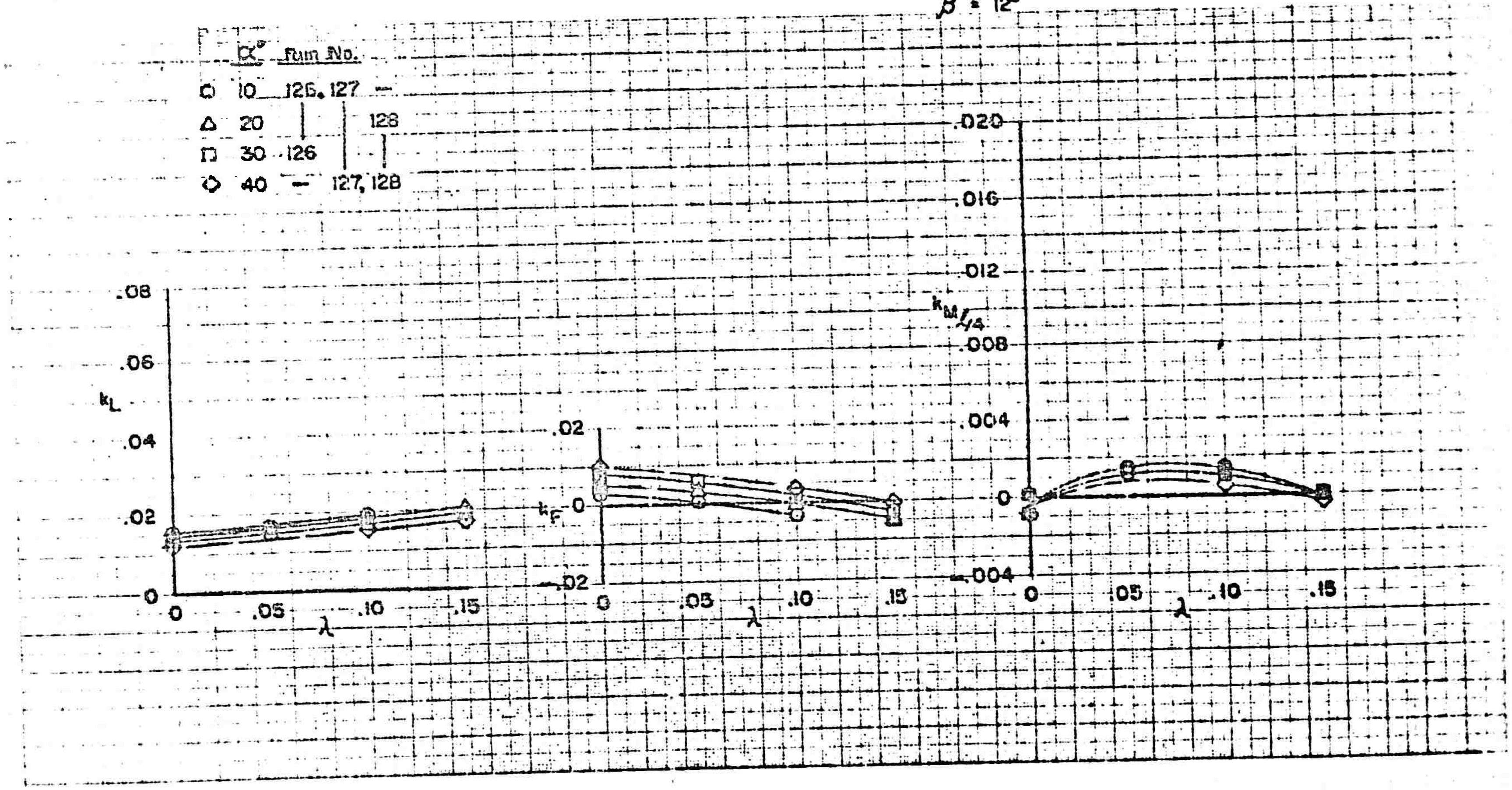

FIGURE 128 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration $D_2 P_p S$

$\alpha = 0°$

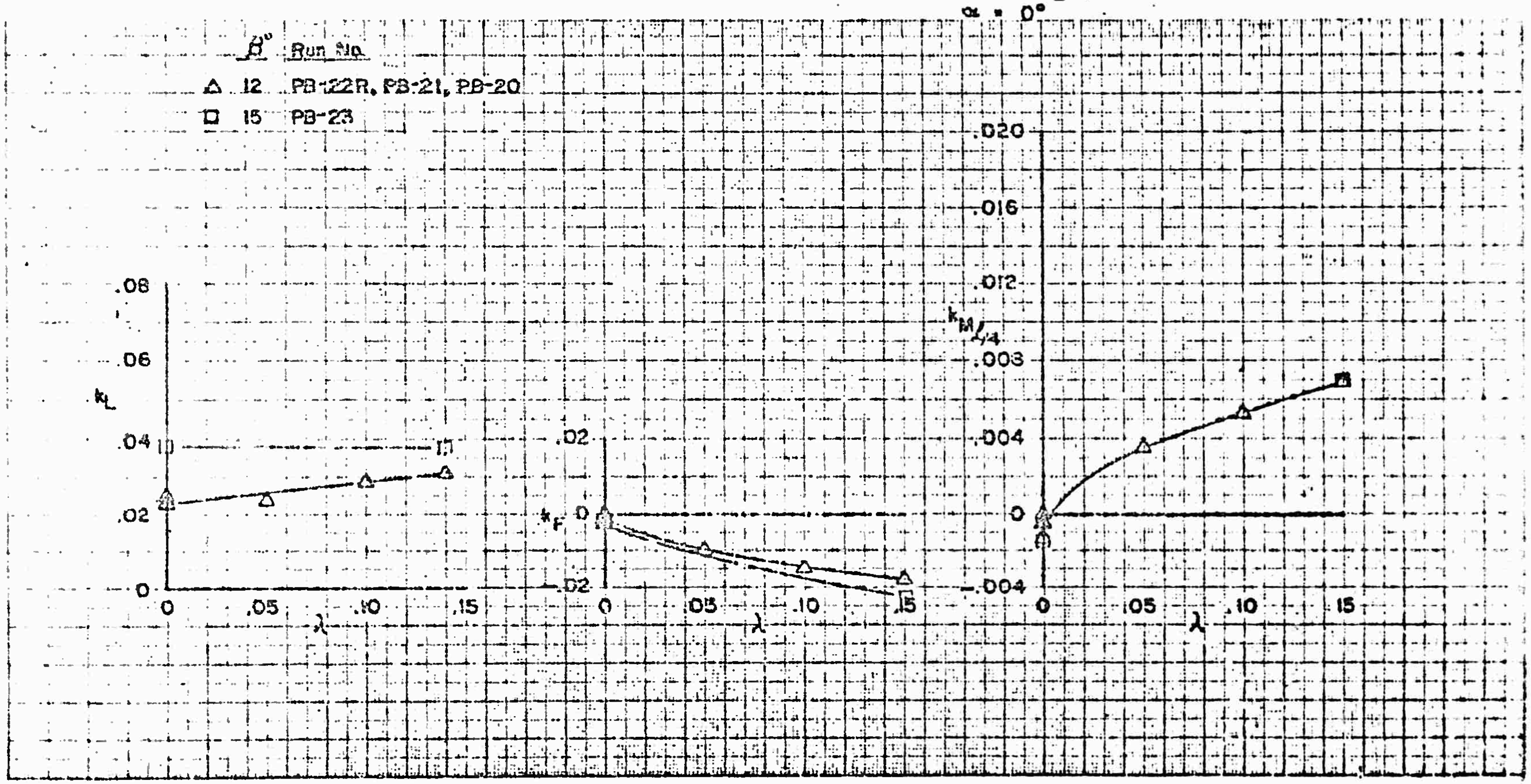

FIGURE 129 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

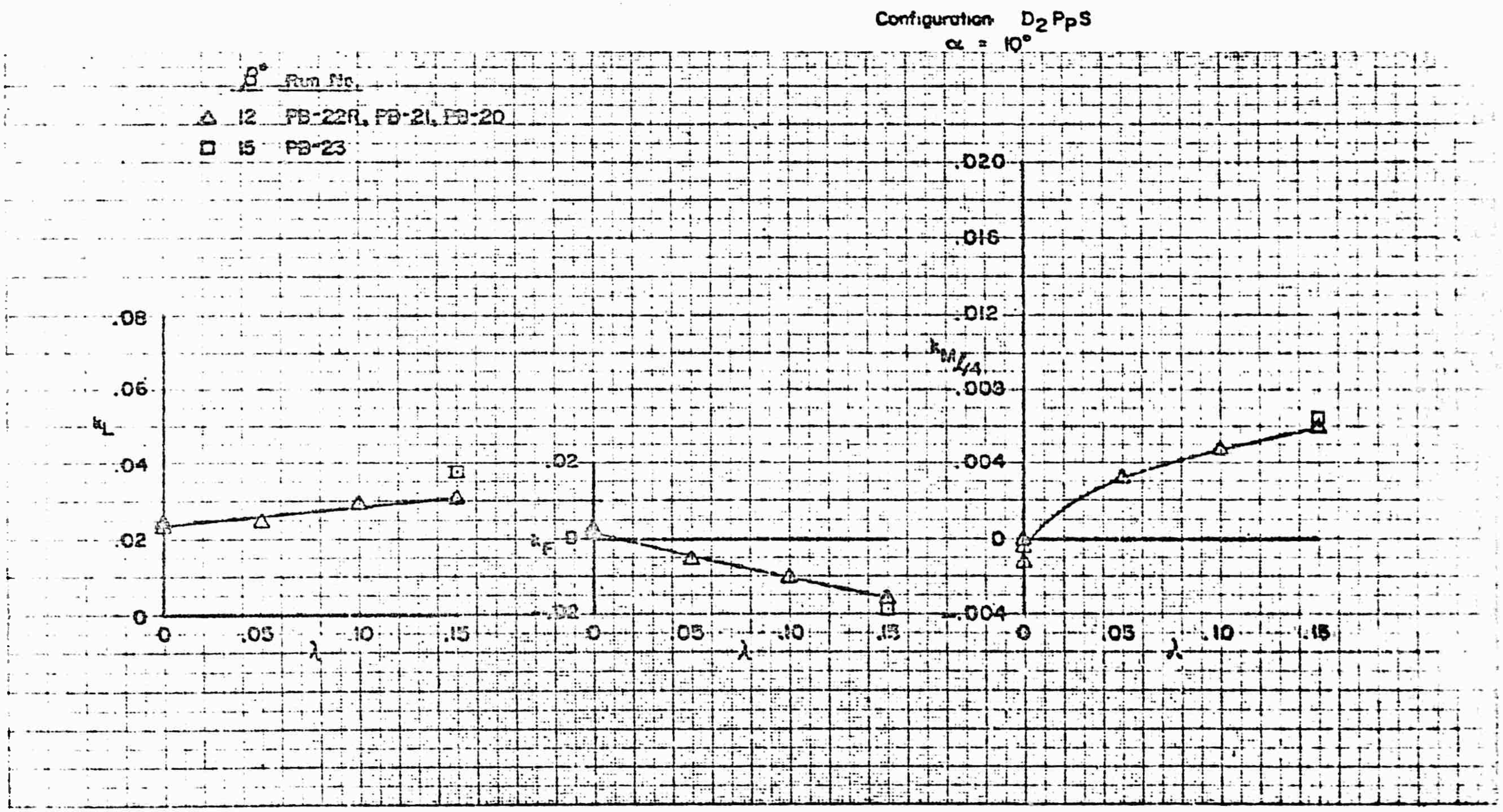

FIGURE 130 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

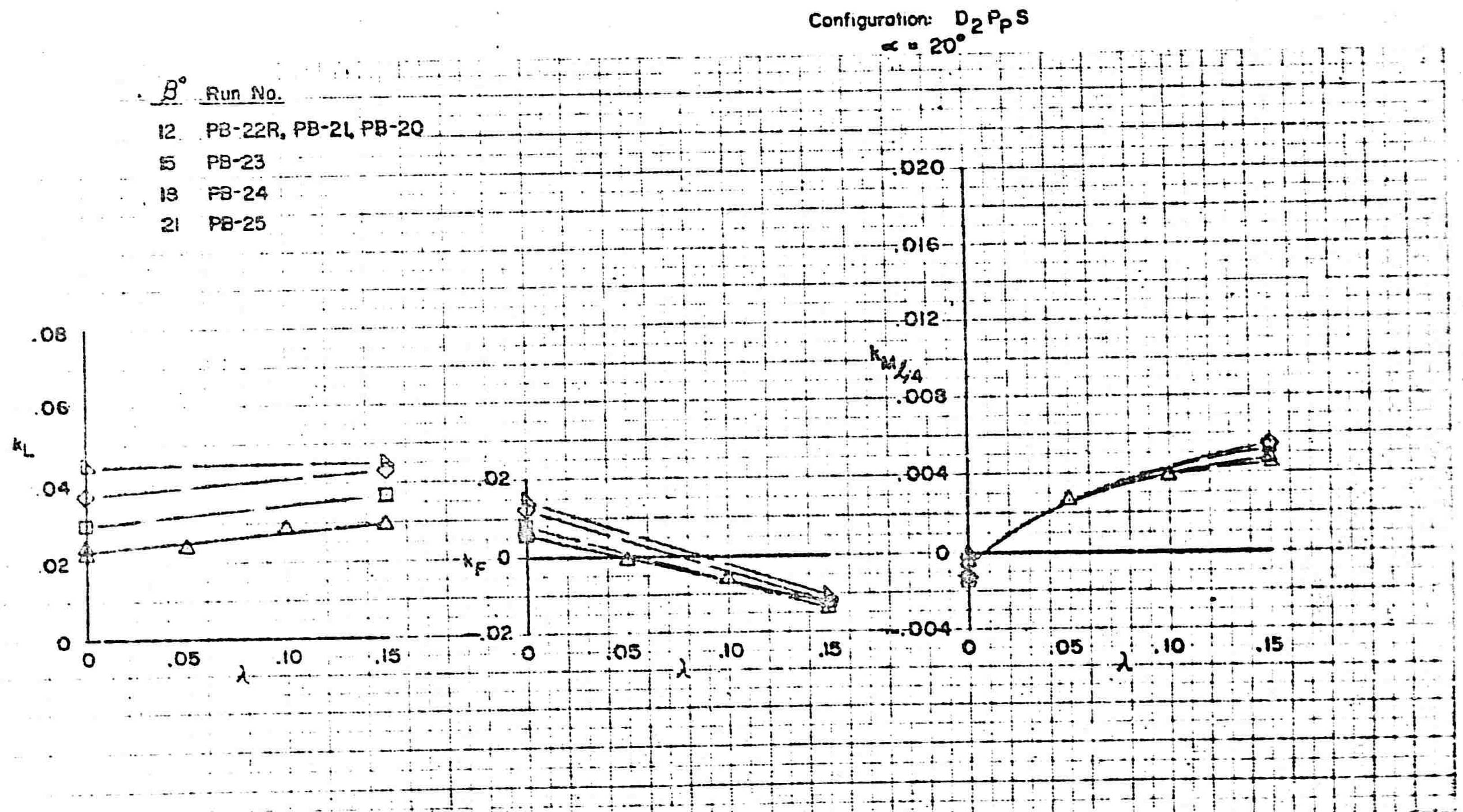

FIGURE 131 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: $D_2 P_P S$

$\alpha = 30°$

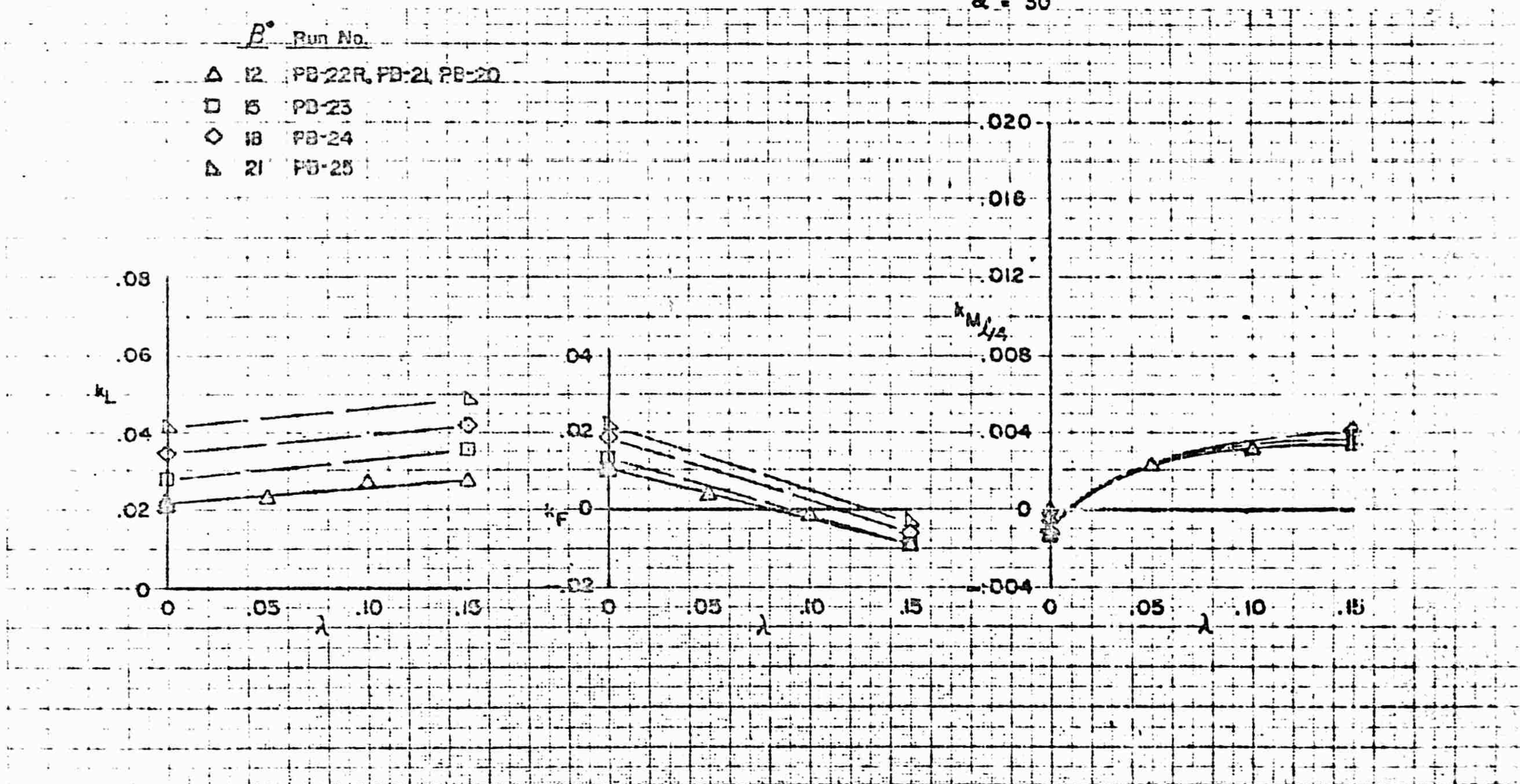

FIGURE 132 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

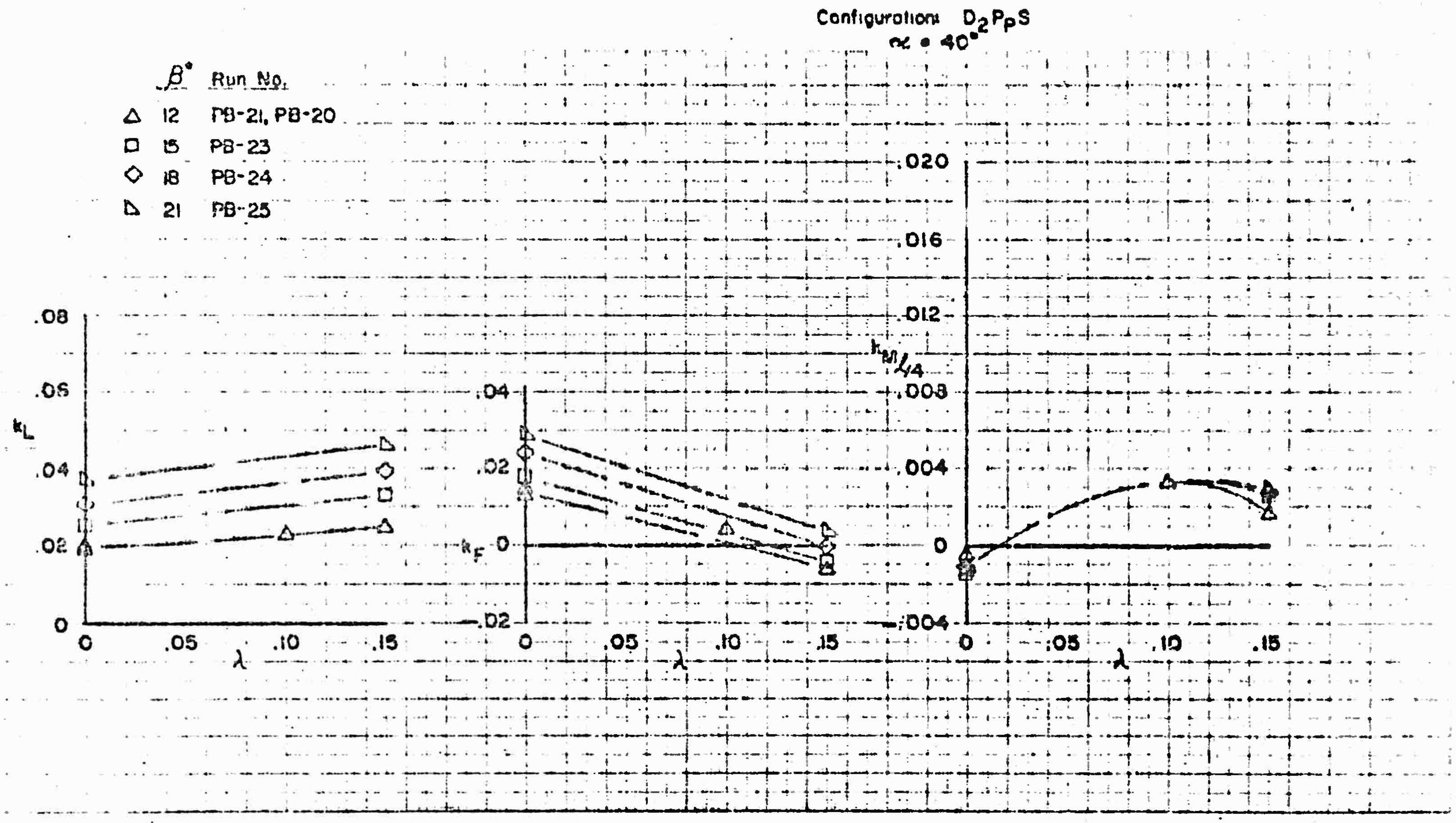

FIGURE 133 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration $D_2 P_p S$

$\alpha = 50°$

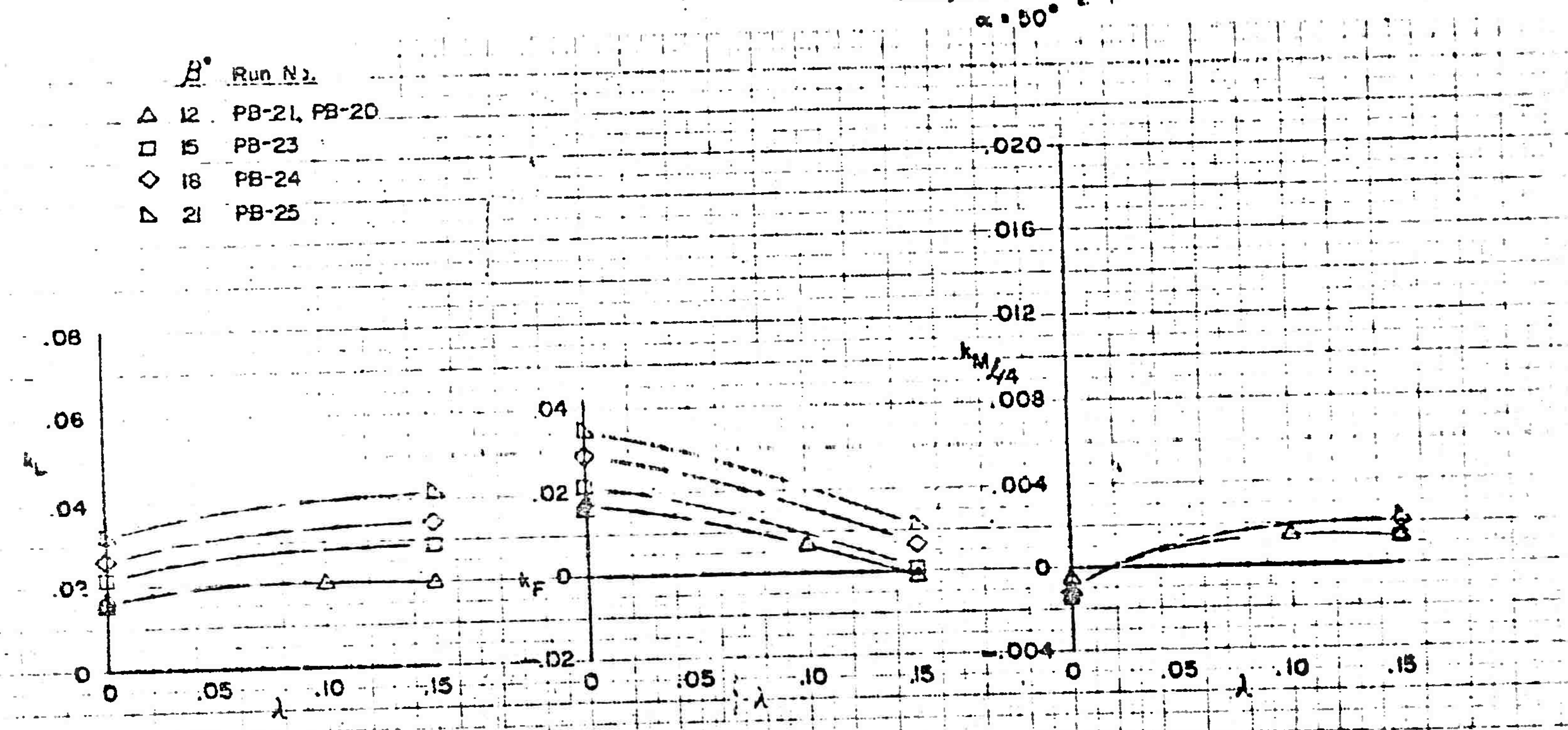

FIGURE 134 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration P_3S

$\alpha = 10°$

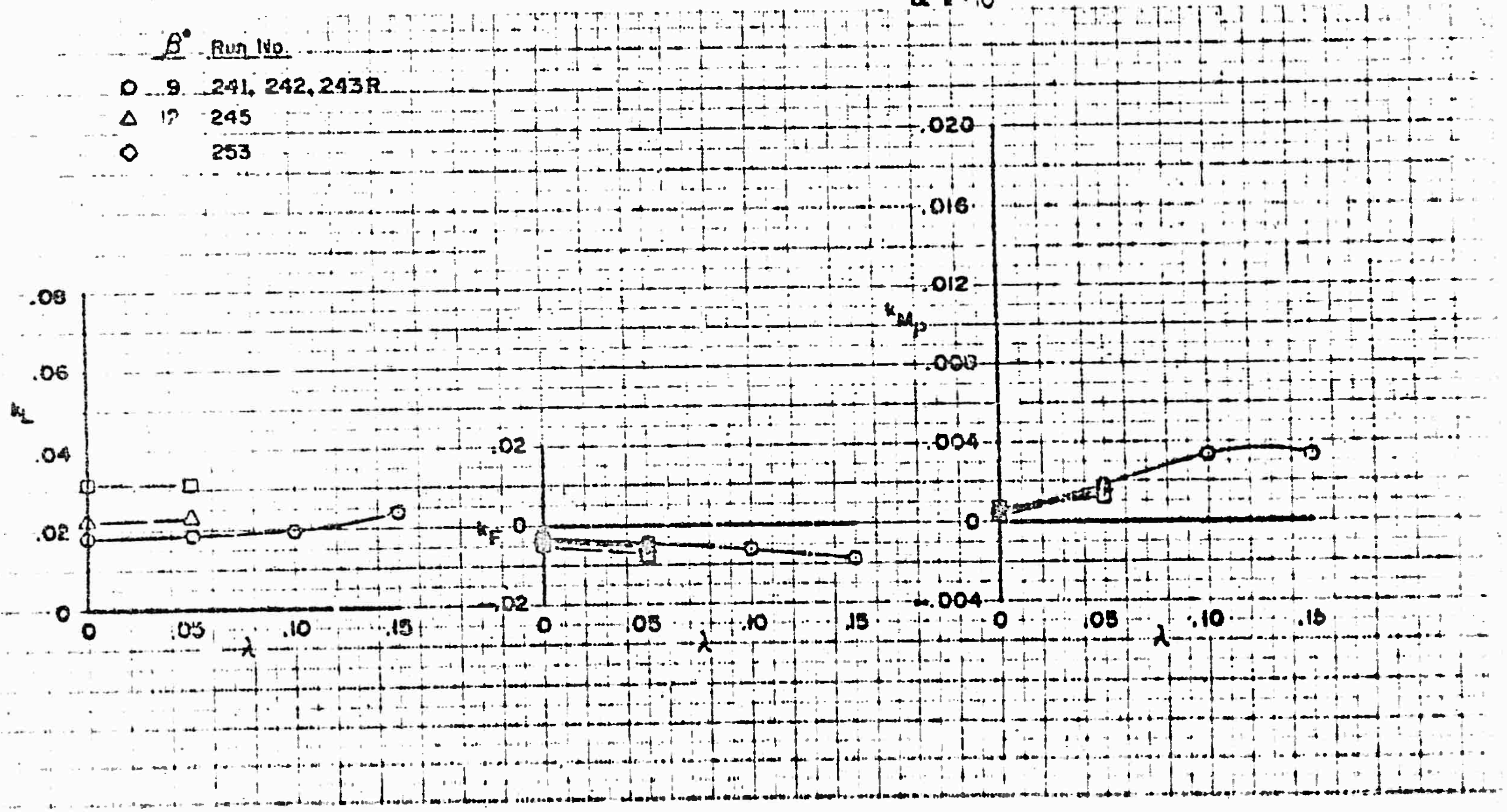

FIGURE 135 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

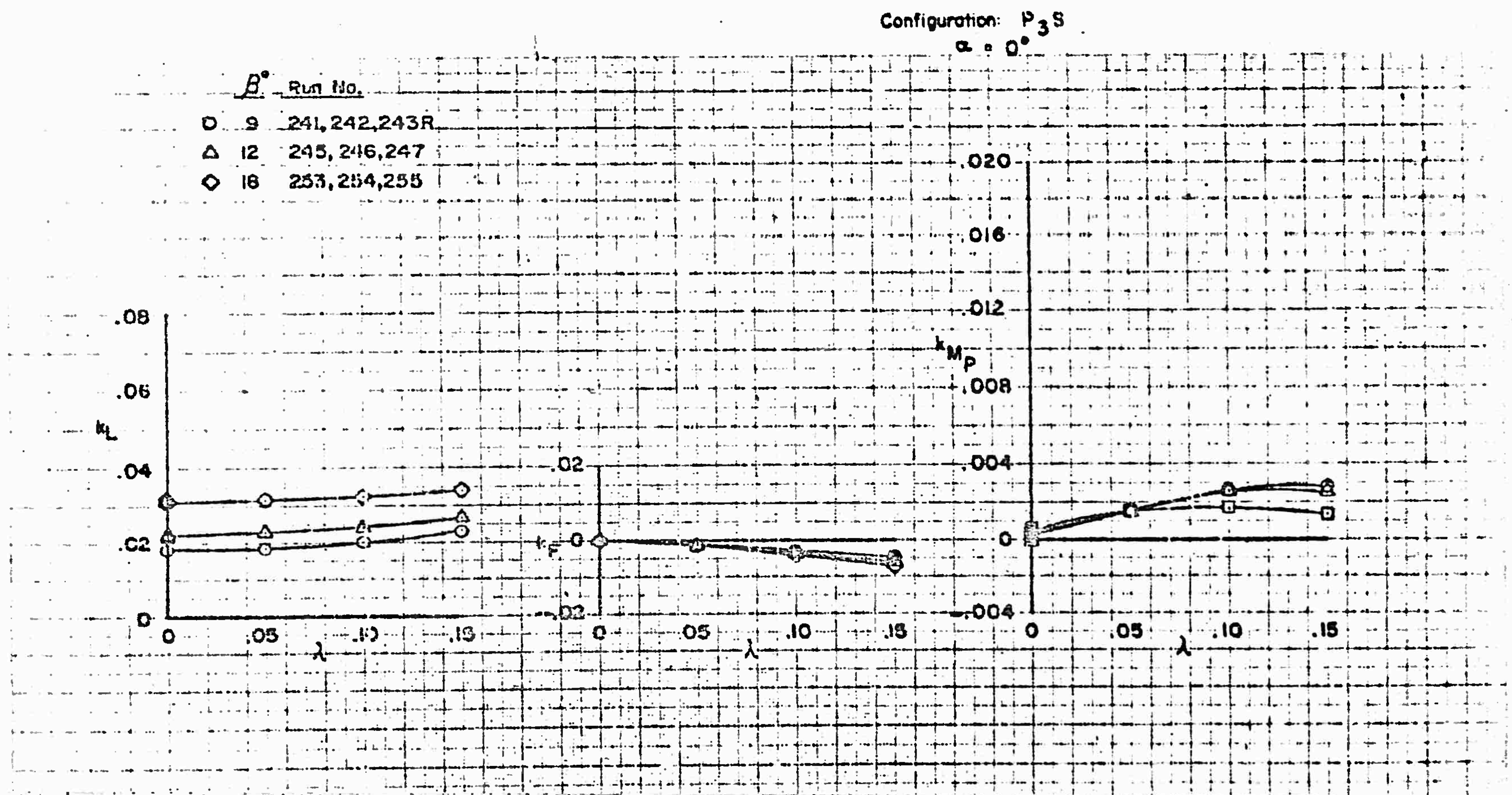

FIGURE 136 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO.

Contract Nonr 1357 (00) Phase IV

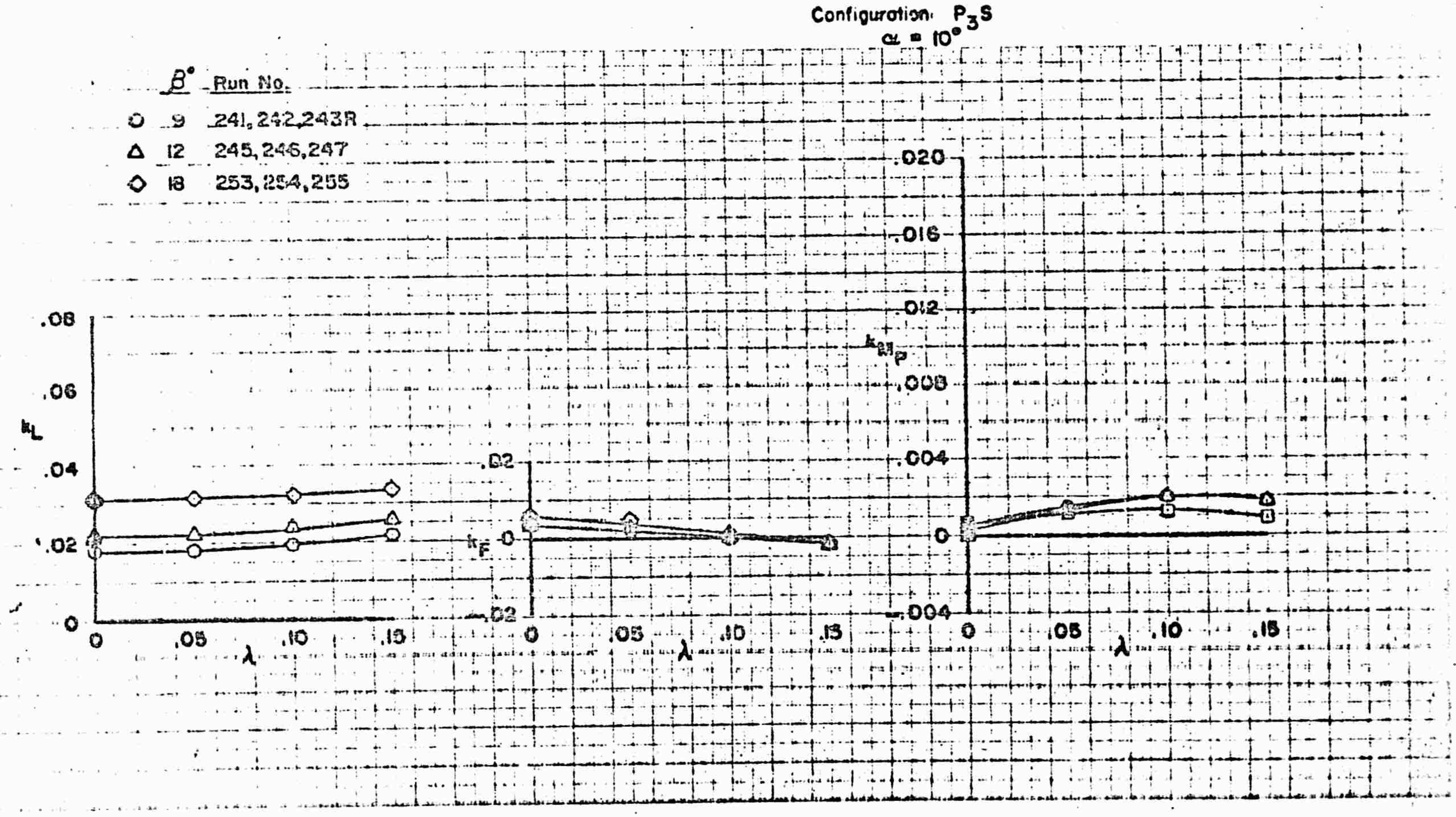

FIGURE 137 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration P_3S
$\alpha = 20°$

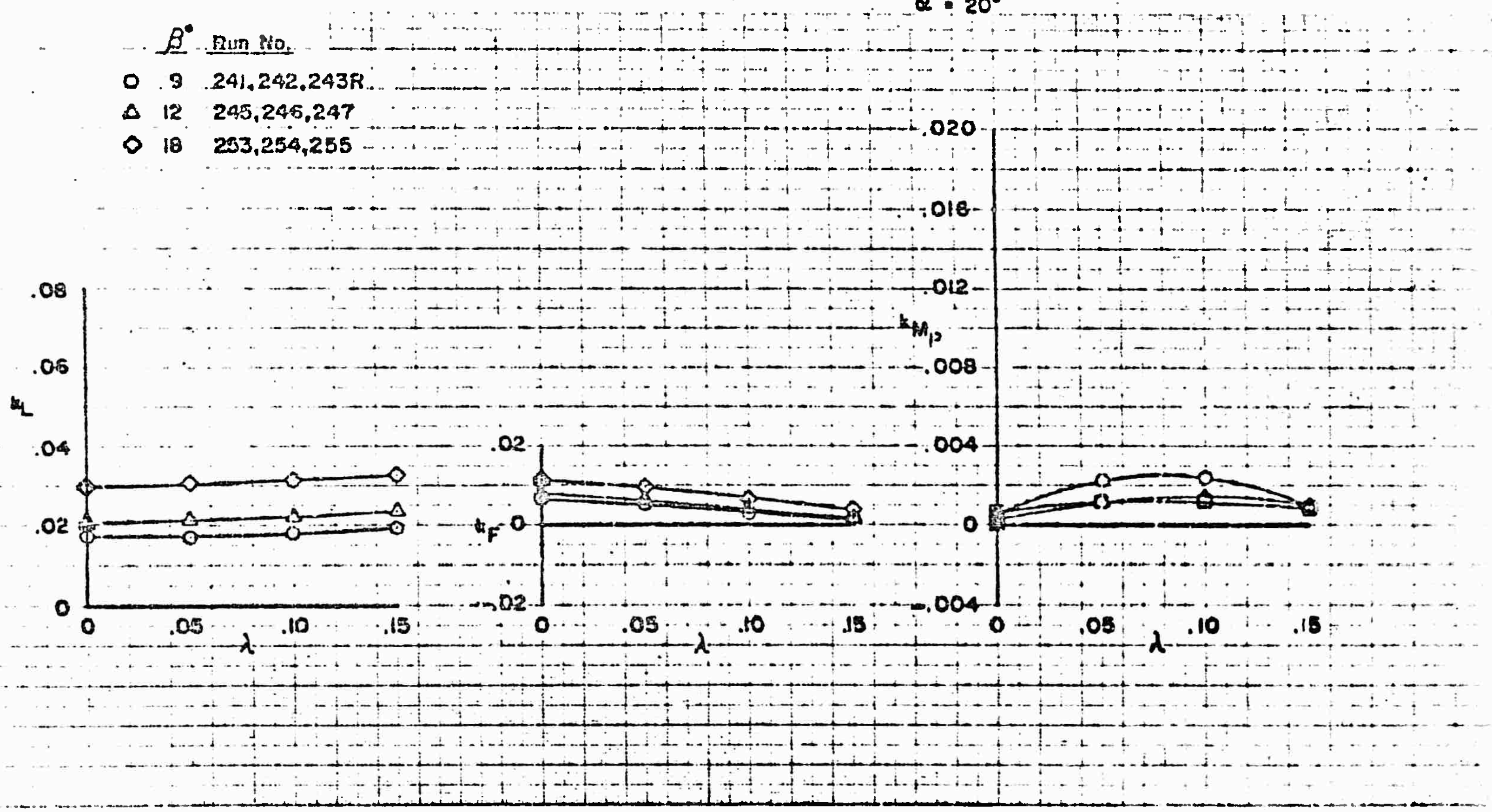

FIGURE 138 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: P_3S
$\alpha = 30°$

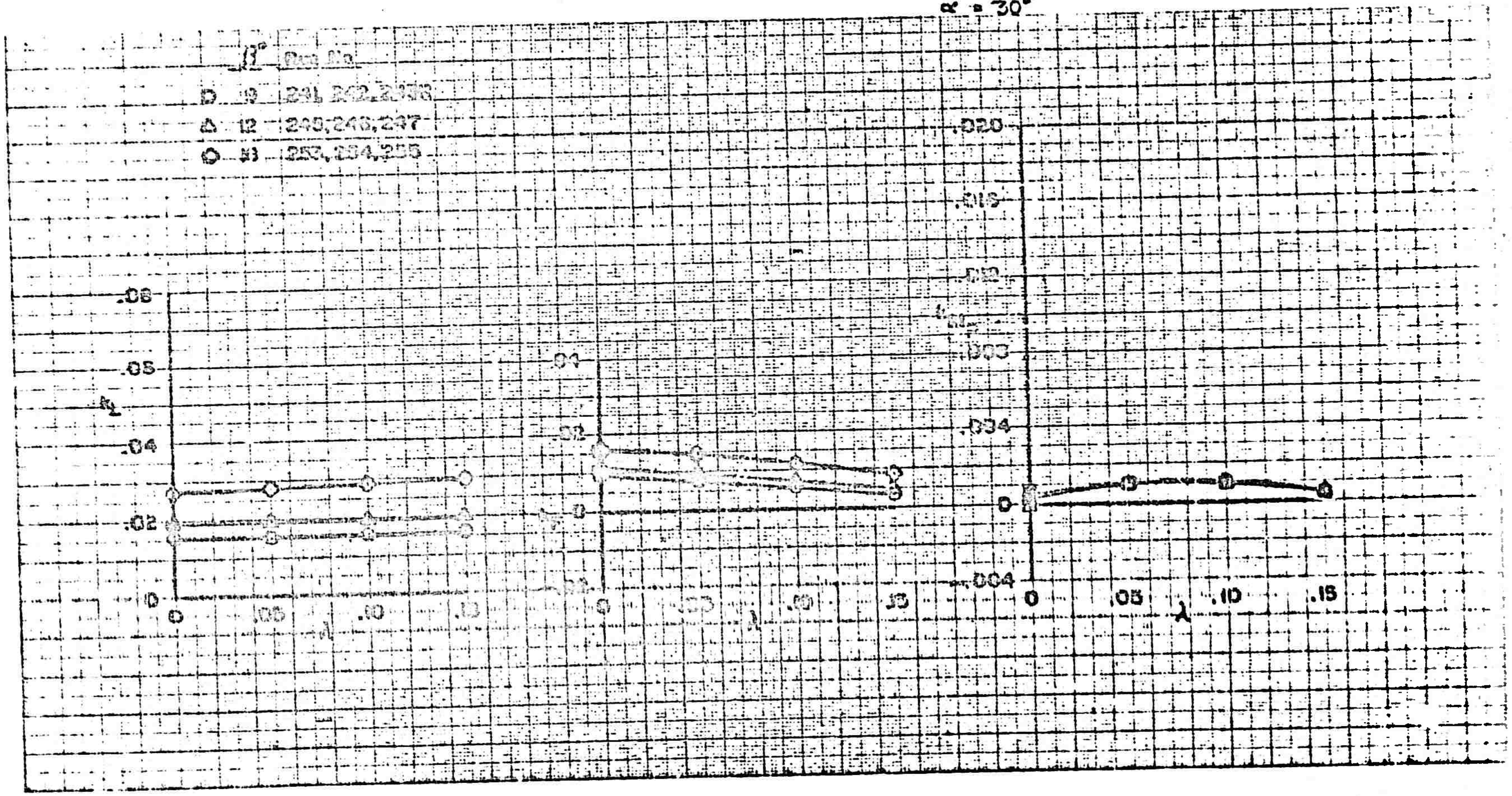

FIGURE 139 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: P_3S
$\alpha = 40°$

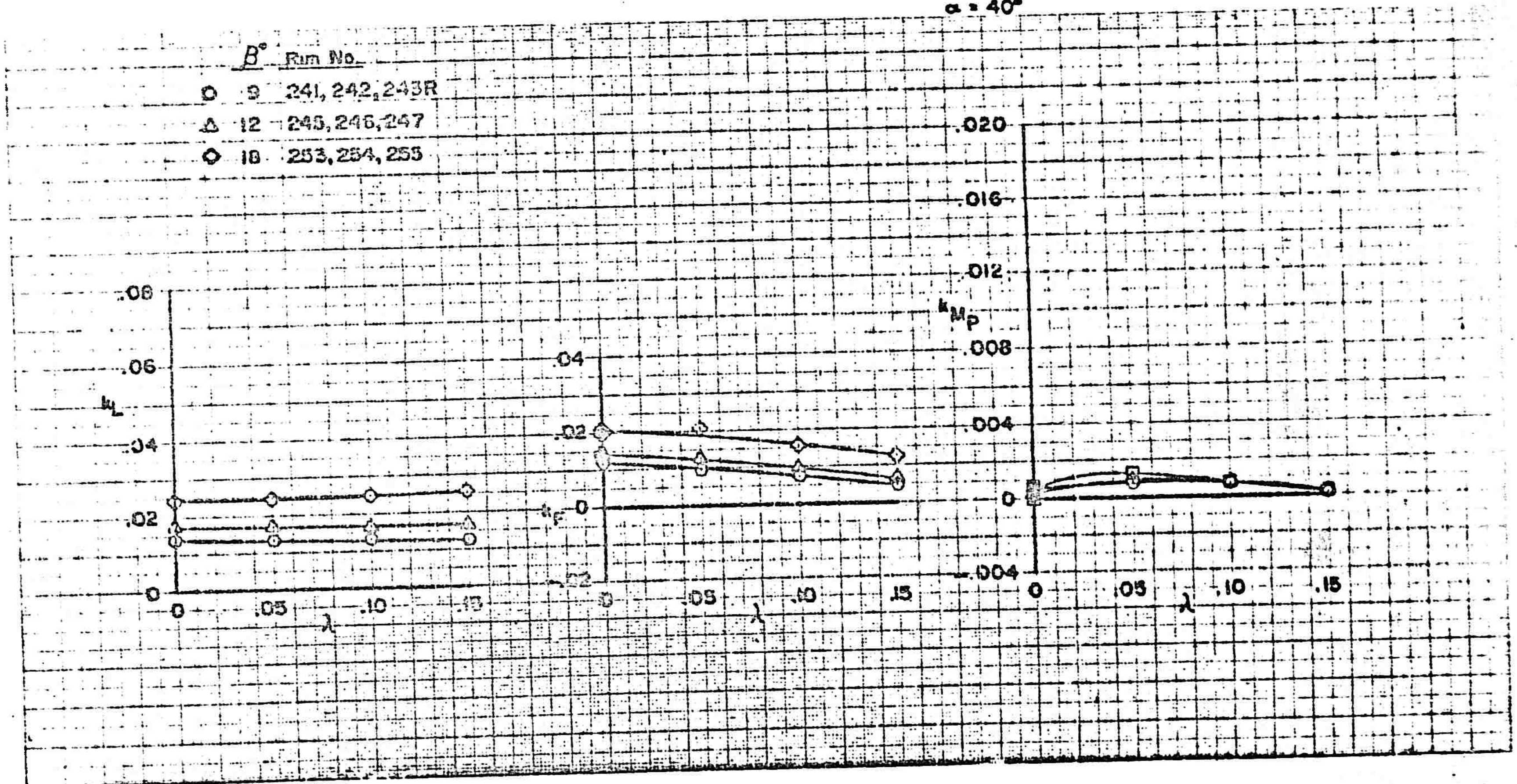

FIGURE 140 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration P_3S
$\alpha = 50^\circ$

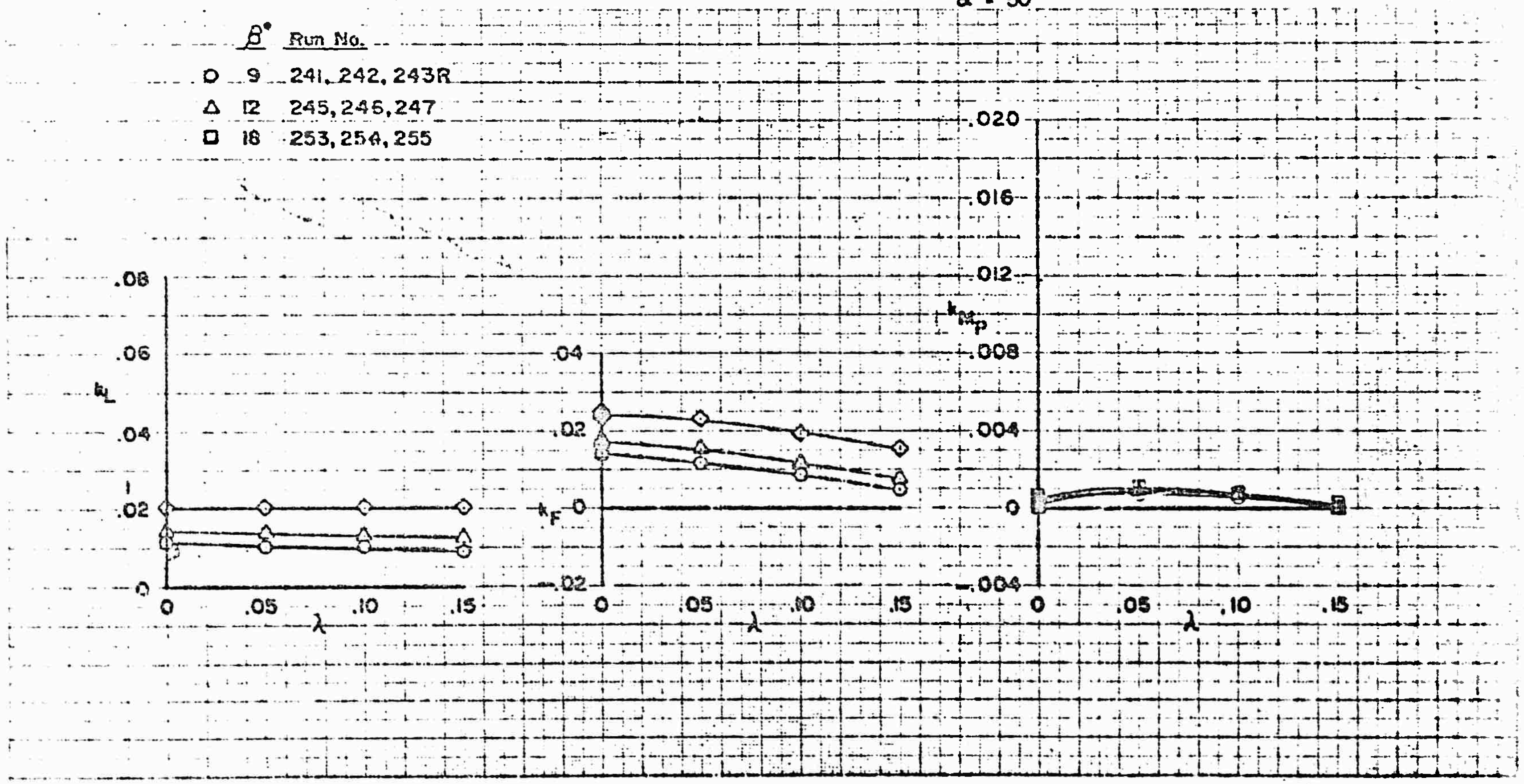

FIGURE 141 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

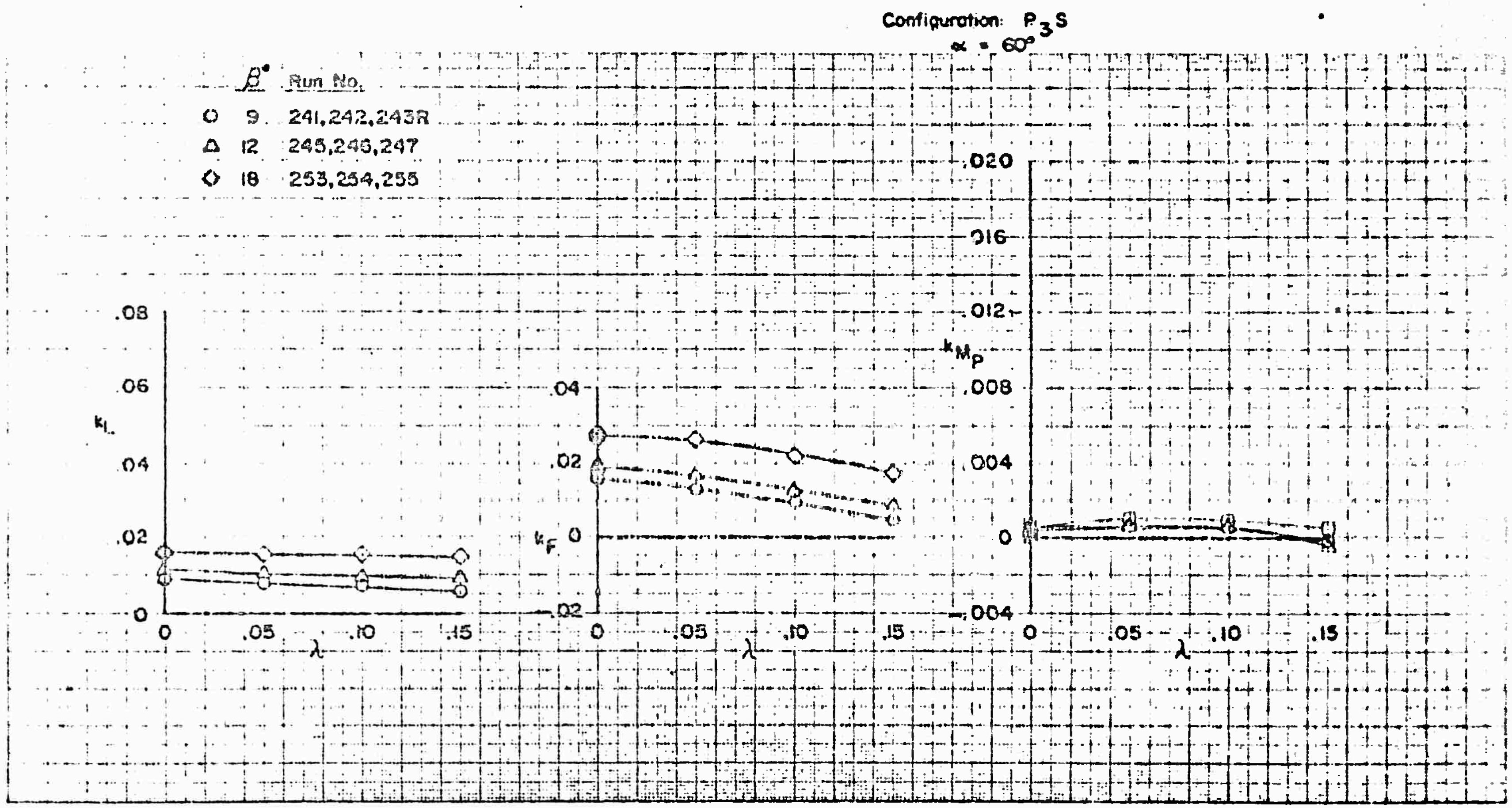

FIGURE 142 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: P_3S
$\alpha = 70°$

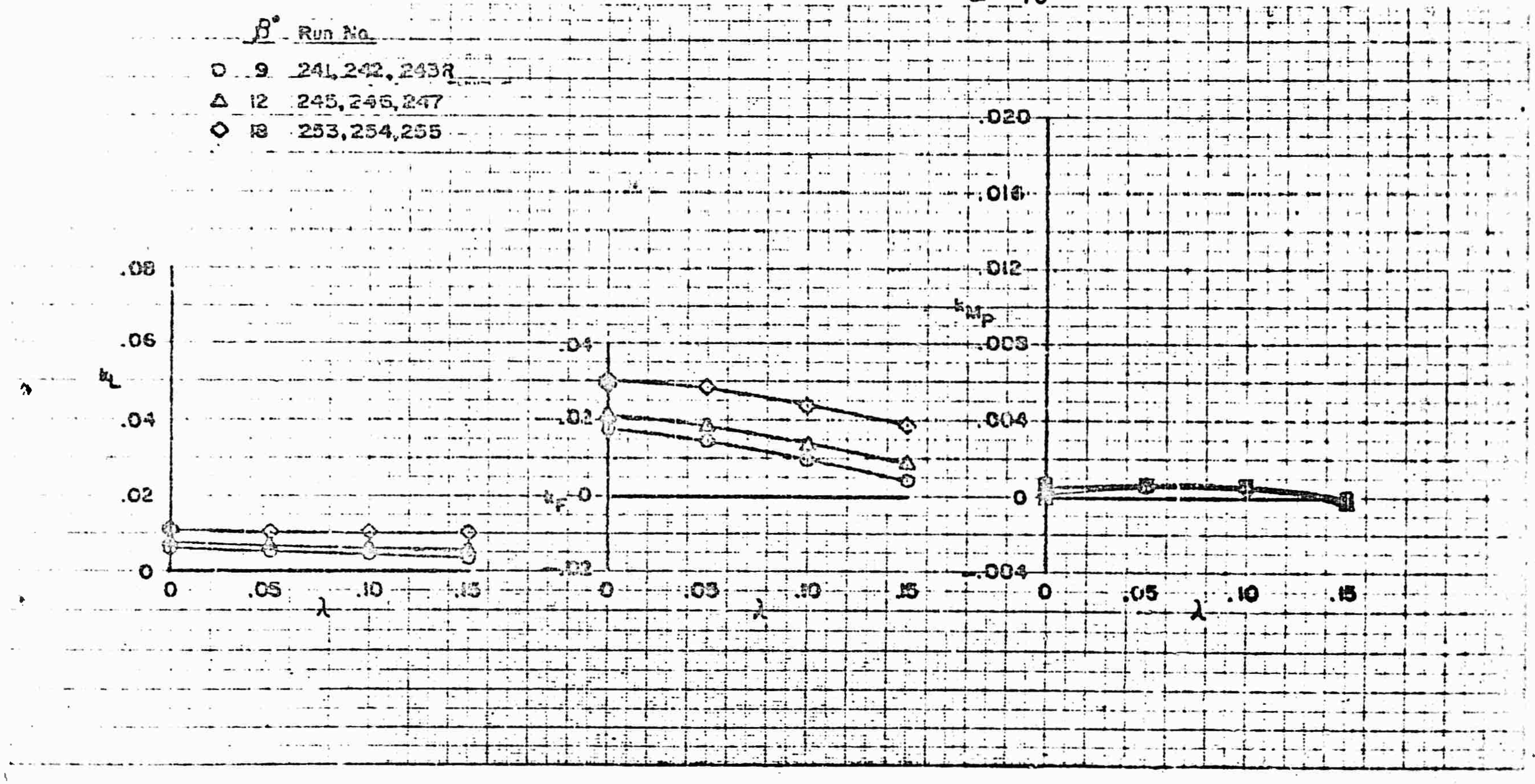

FIGURE 143 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

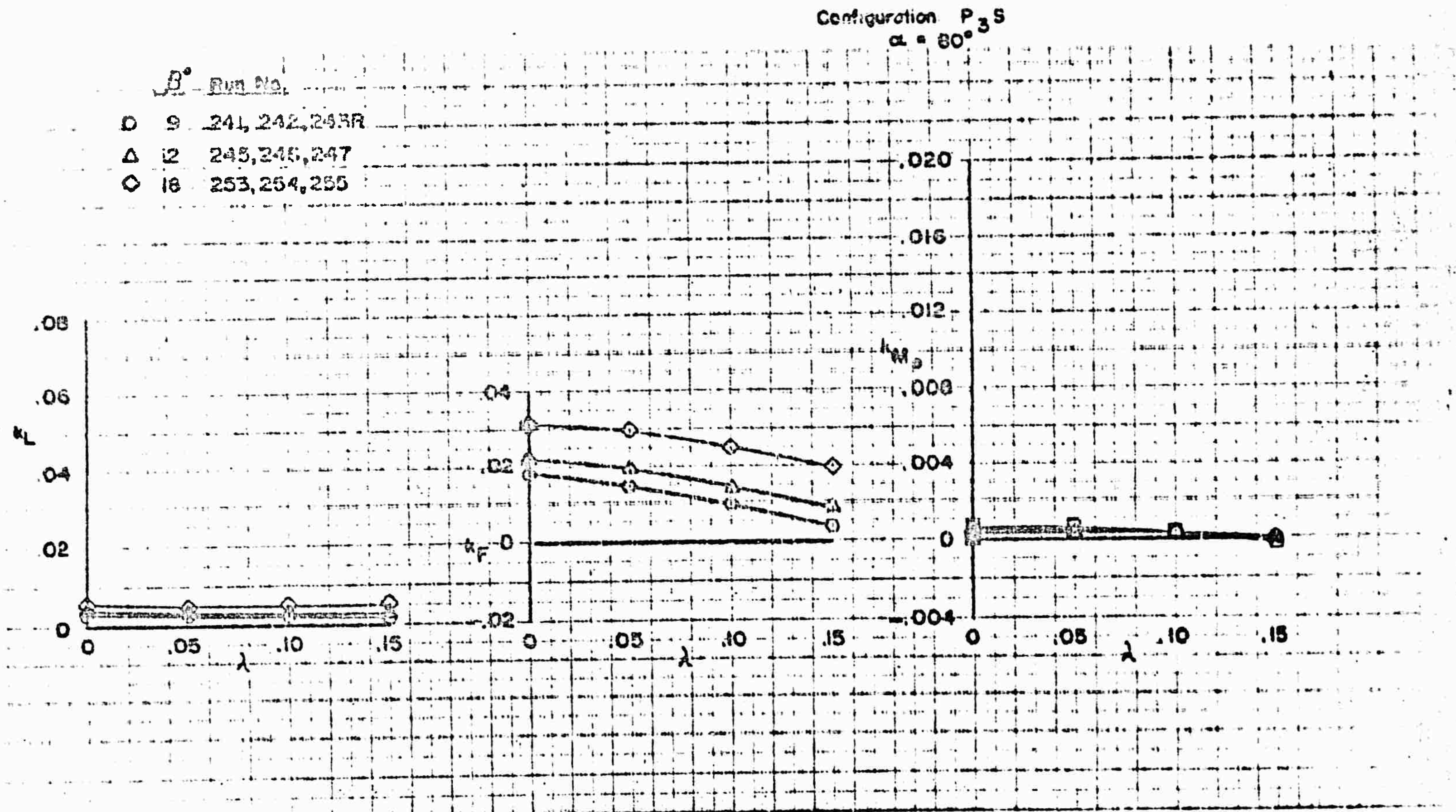

FIGURE 144 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: P_3S

$\alpha = 90°$

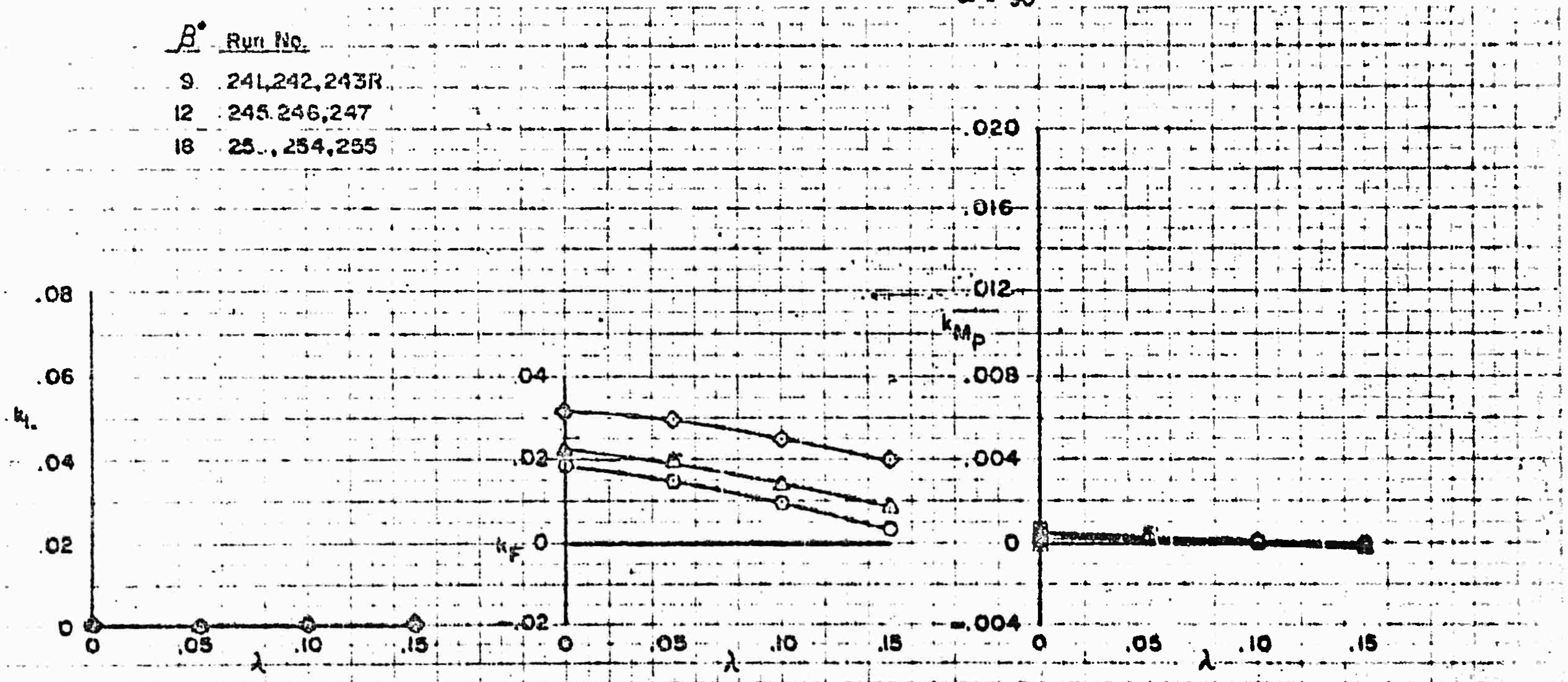

FIGURE 145 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

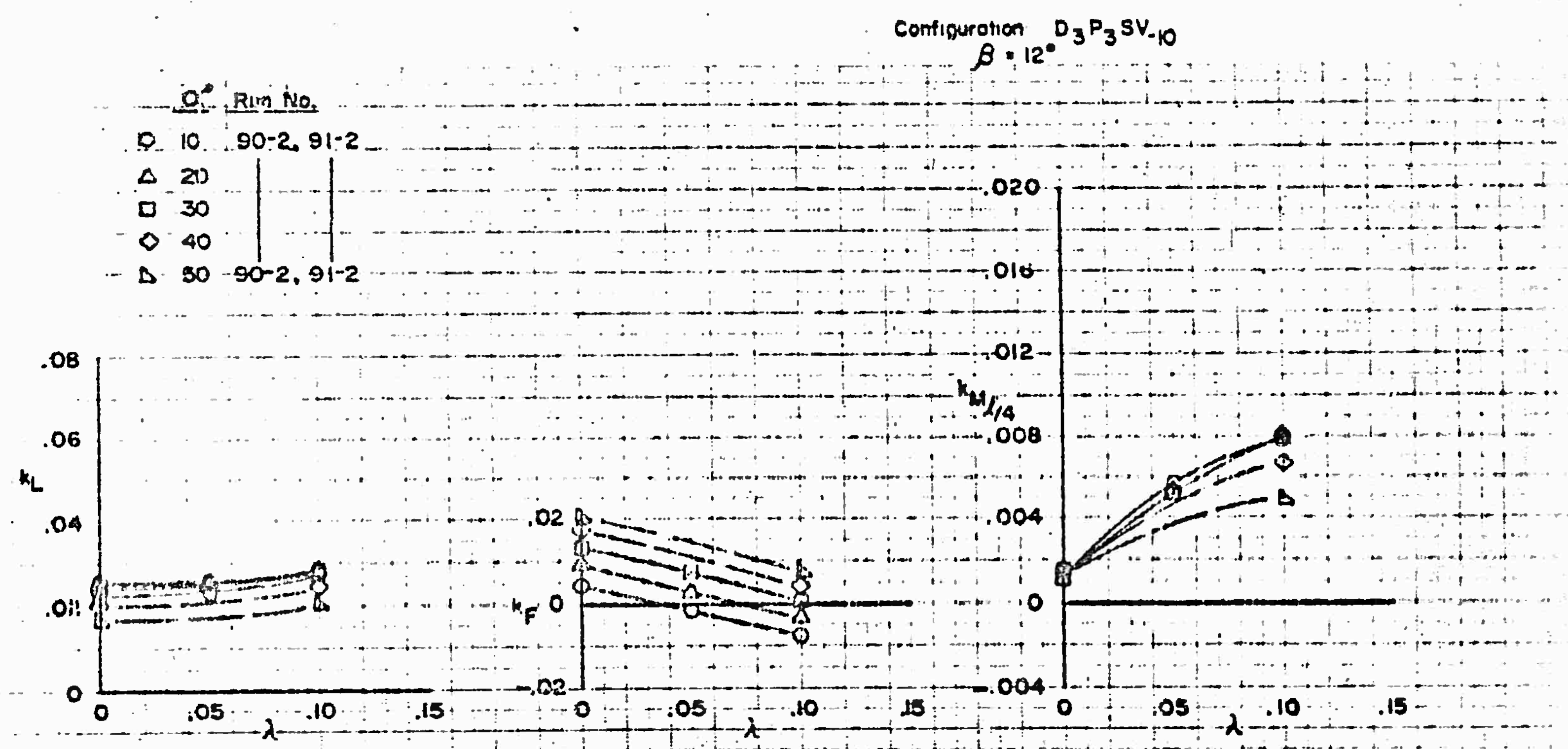

FIGURE 146 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3 P_3 SV_{-5}$, $\beta = 12°$

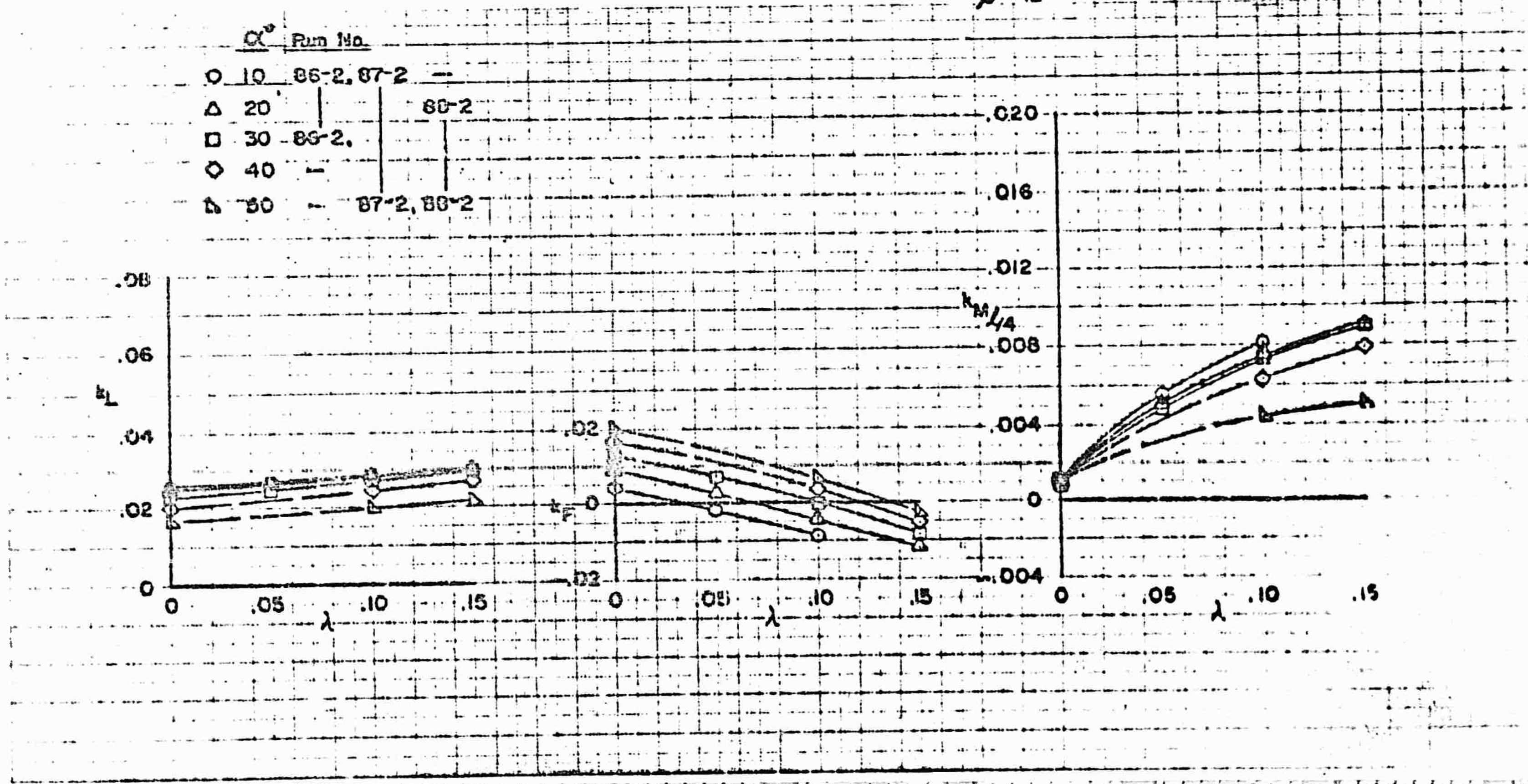

FIGURE 147 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3SV_0$

$\beta = 12°$

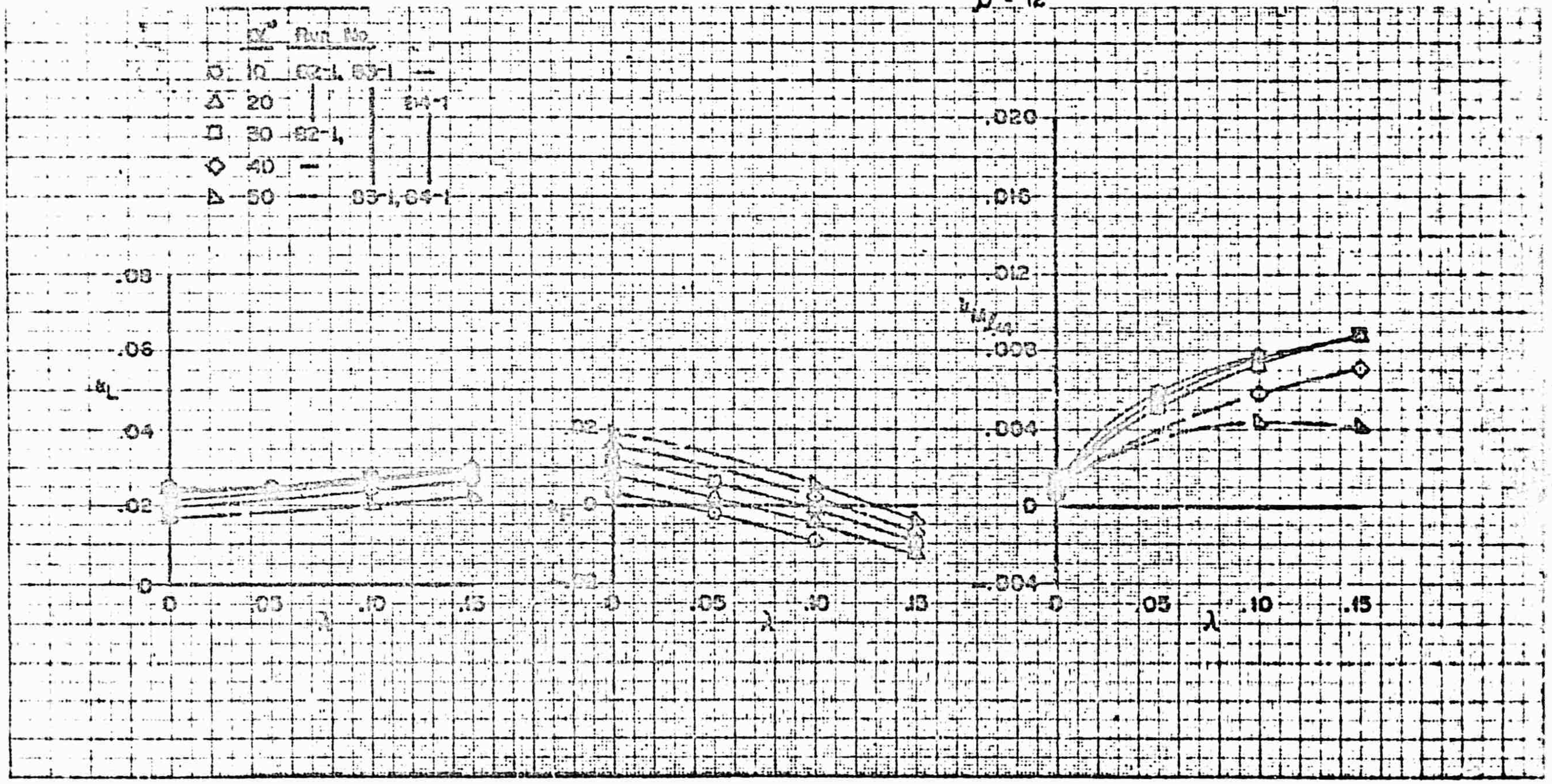

FIGURE 148 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

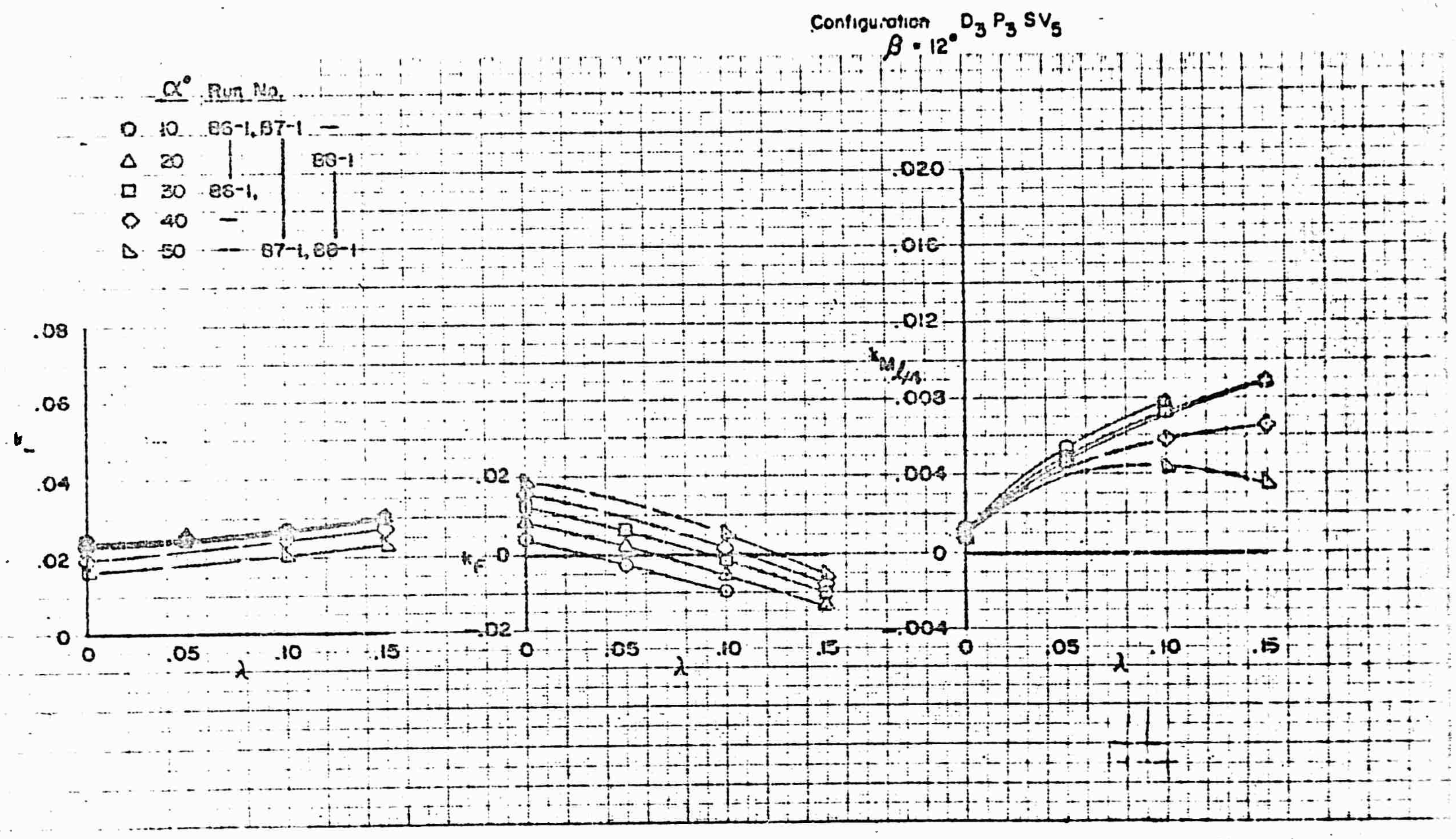

FIGURE 149 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration $D_3 P_3 SV_{10}$
$\beta = 12°$

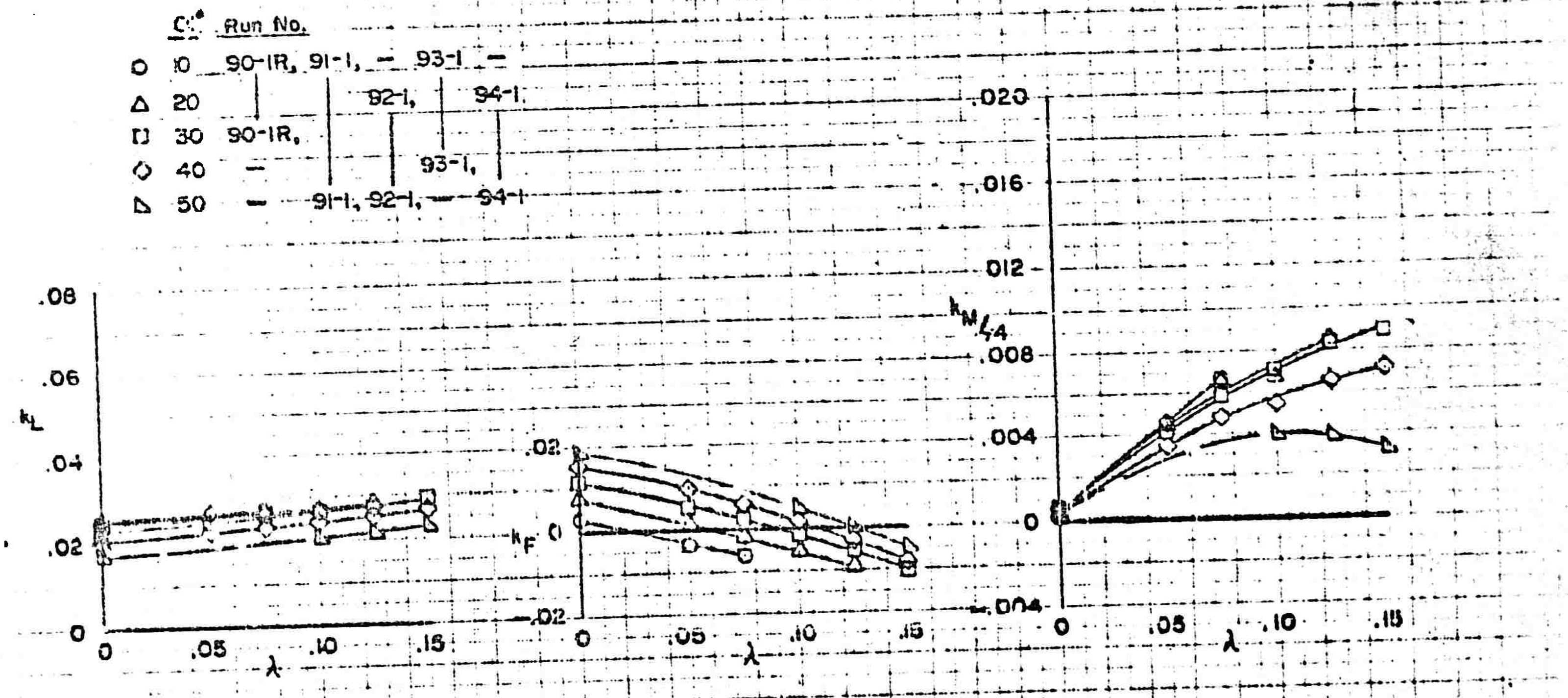

FIGURE 150 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO.

Contract Nonr 1357 (00) Phase IV

Configuration $D_2 P_3 SV_{15}$

$\beta = 12°$

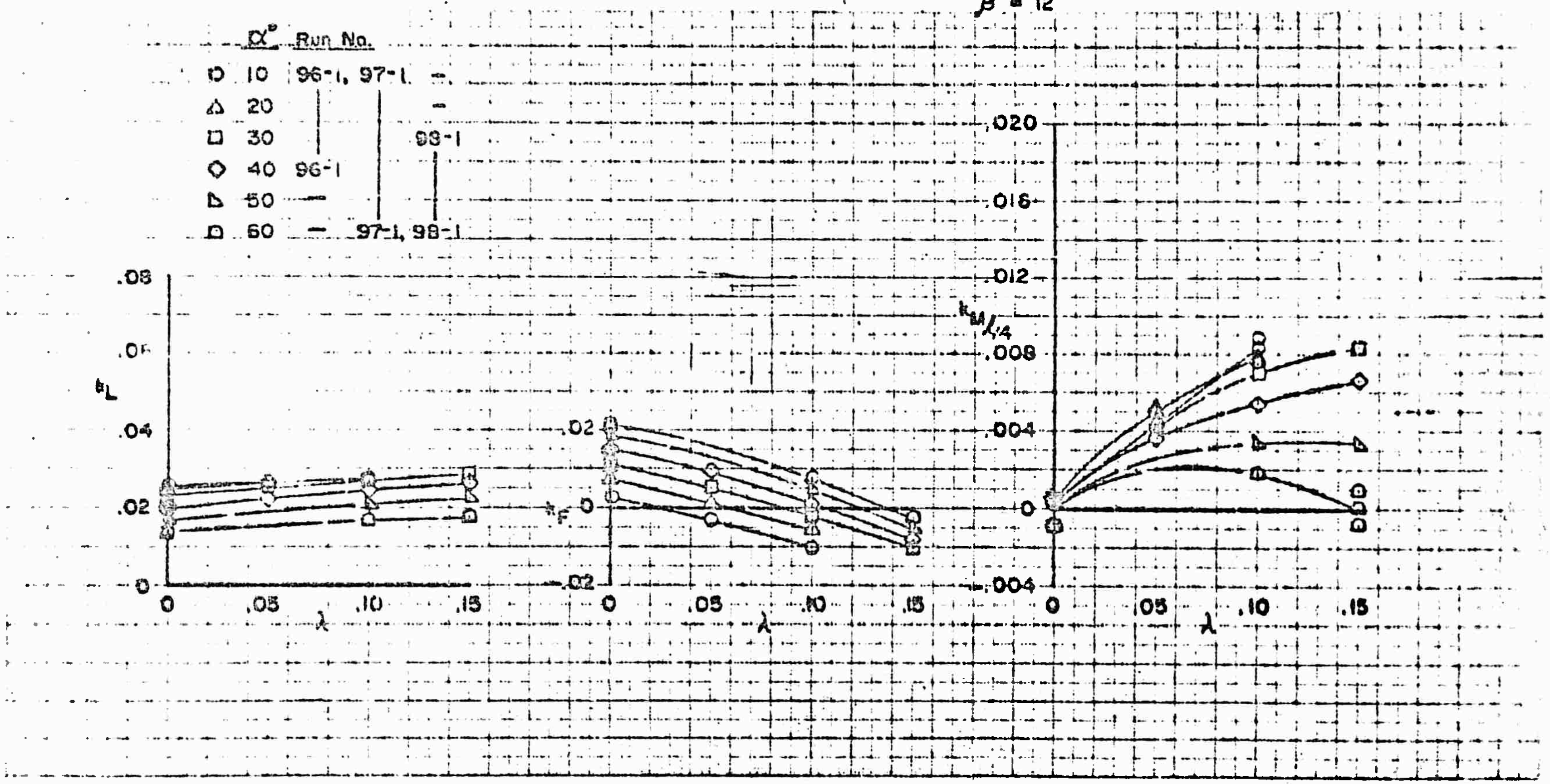

FIGURE 151 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_2 5V_0$
$\beta = 18°$

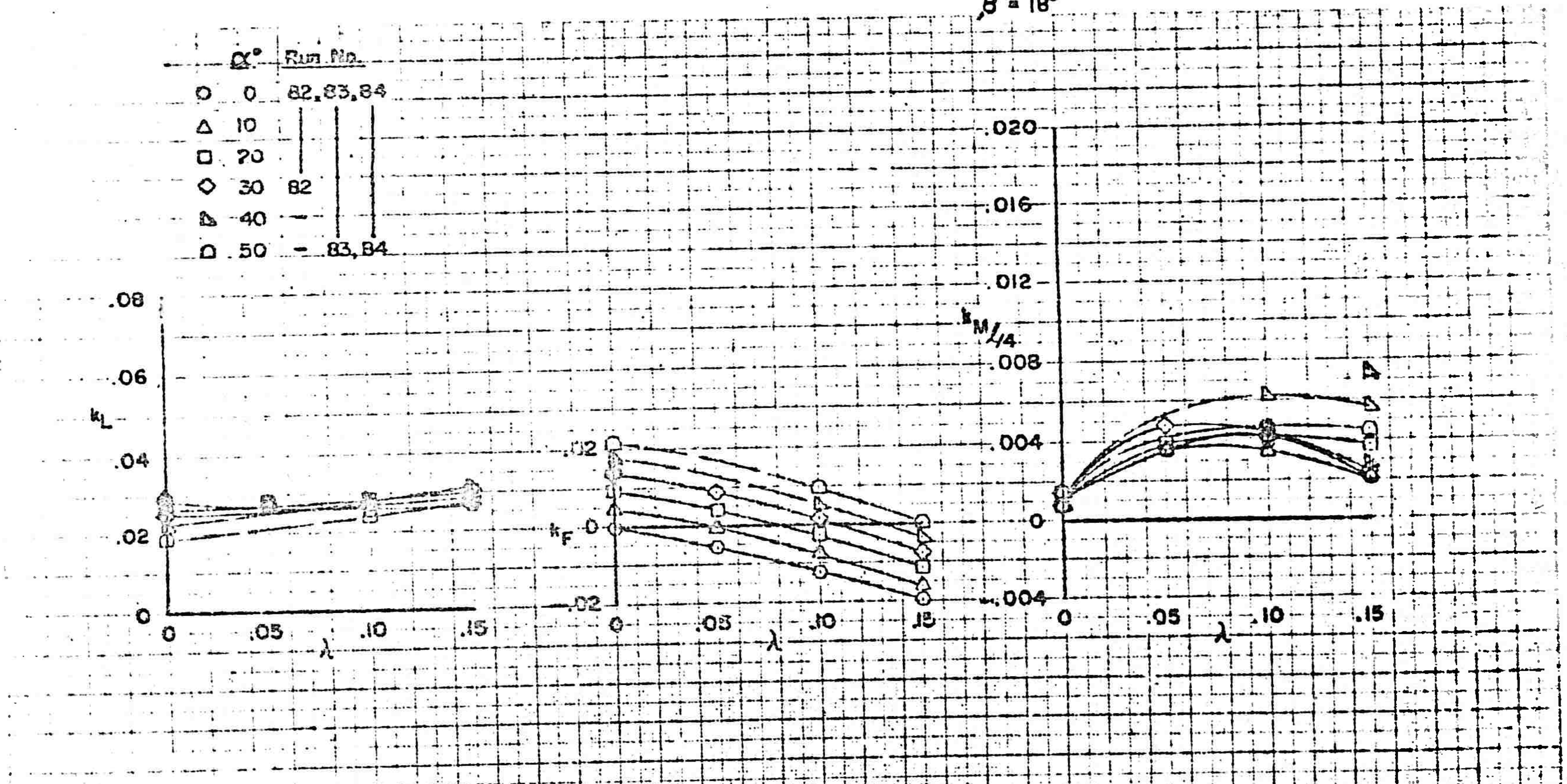

FIGURE 152 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration $D_3 P_3 H$

$\alpha = 10°$

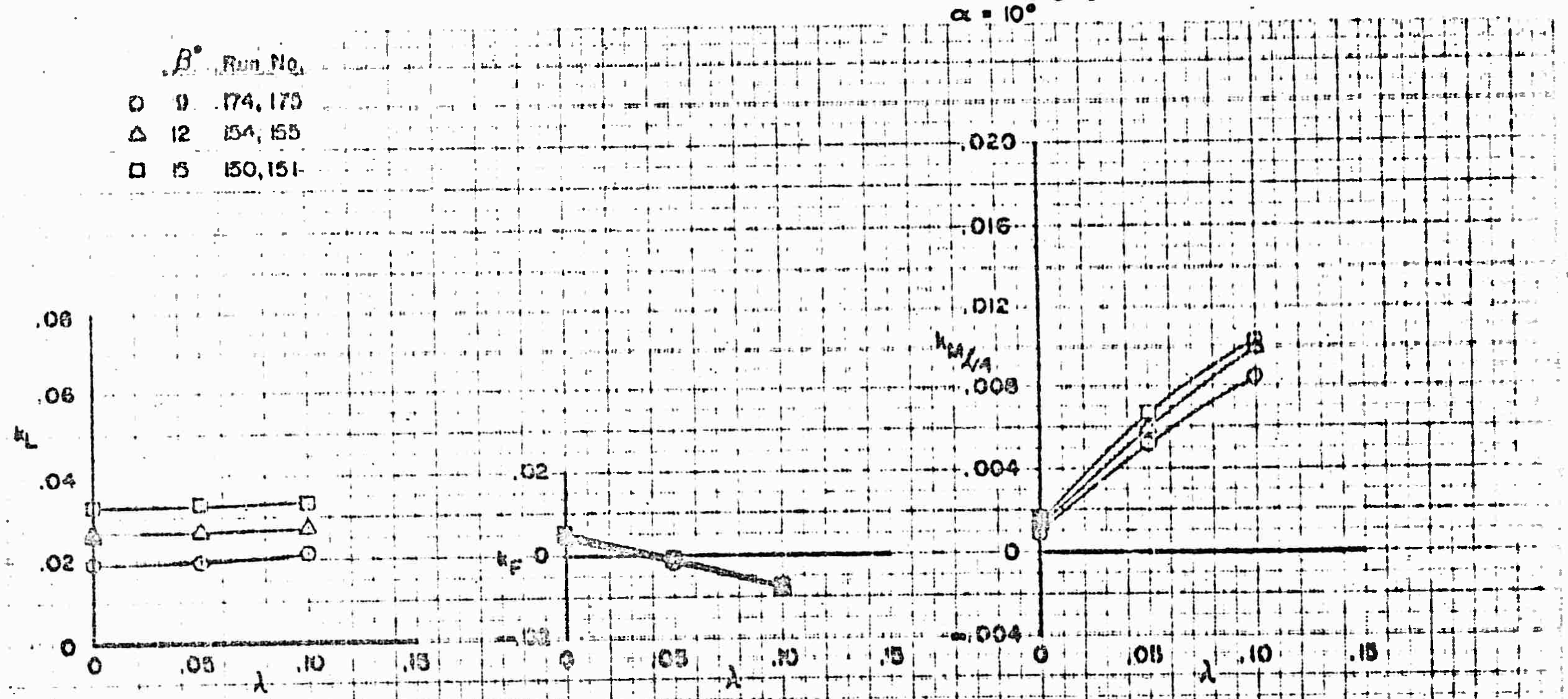

FIGURE 153 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

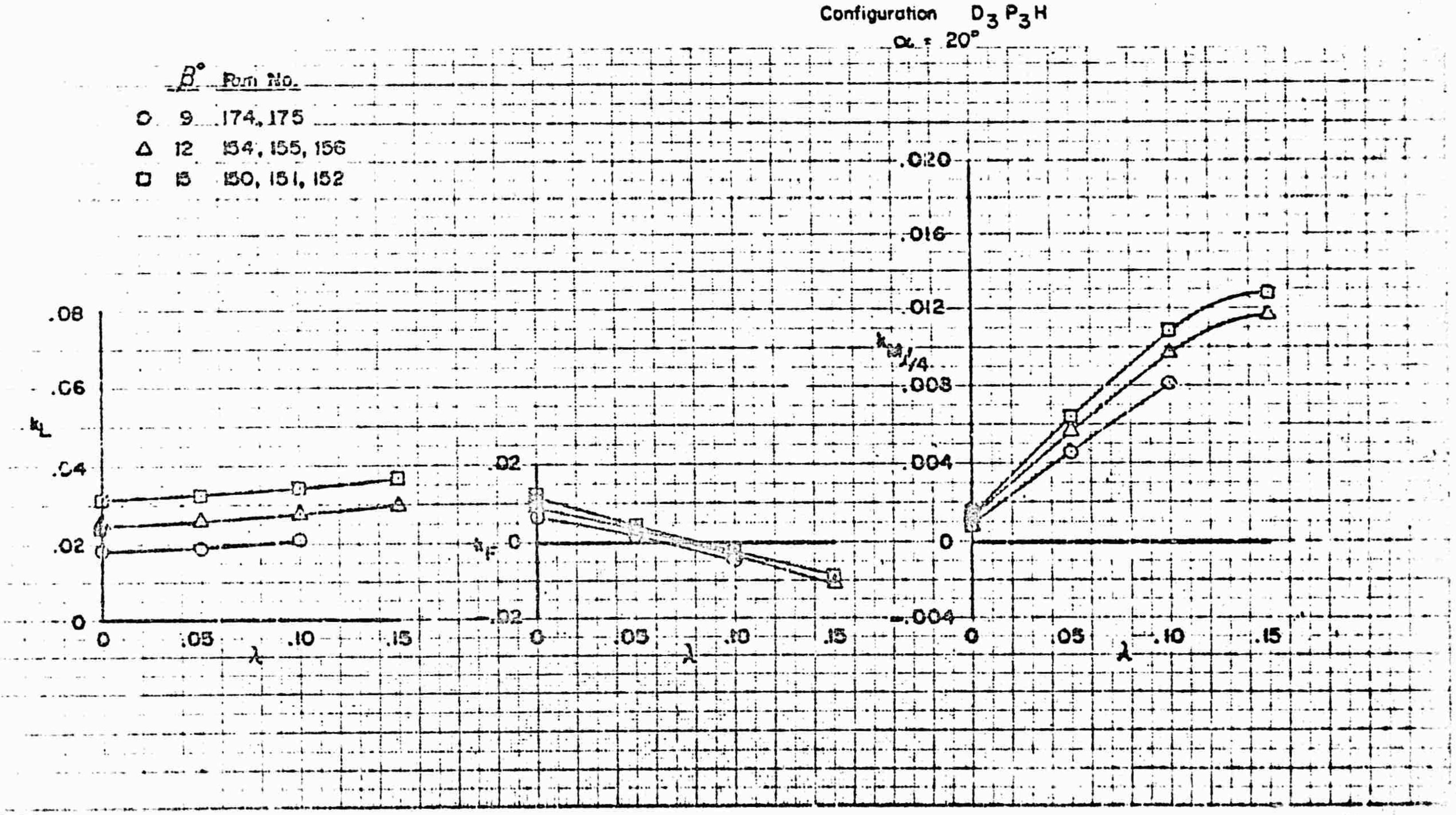

FIGURE 154 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

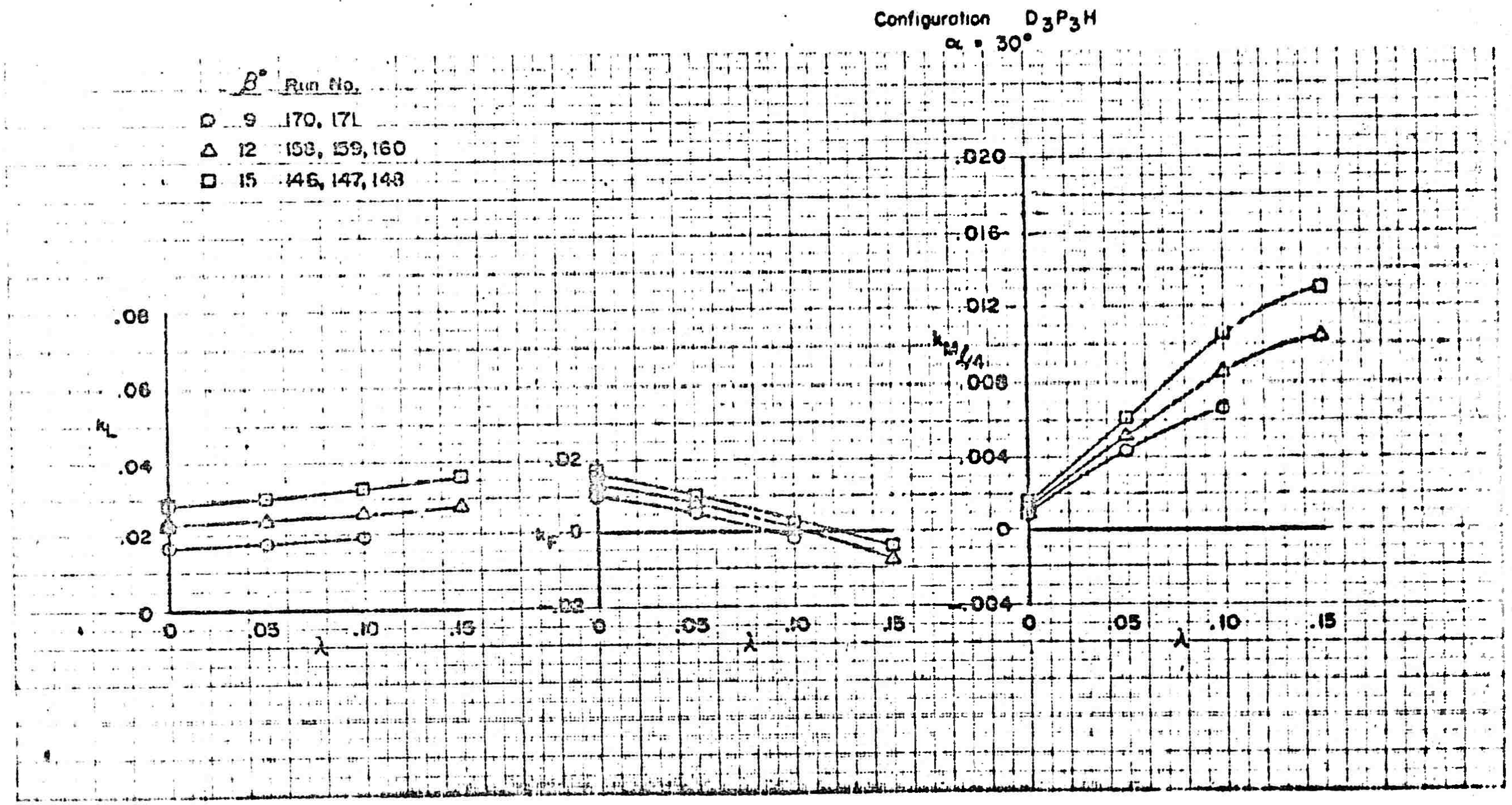

FIGURE 155 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3 P_3 H$
$\alpha = 40°$

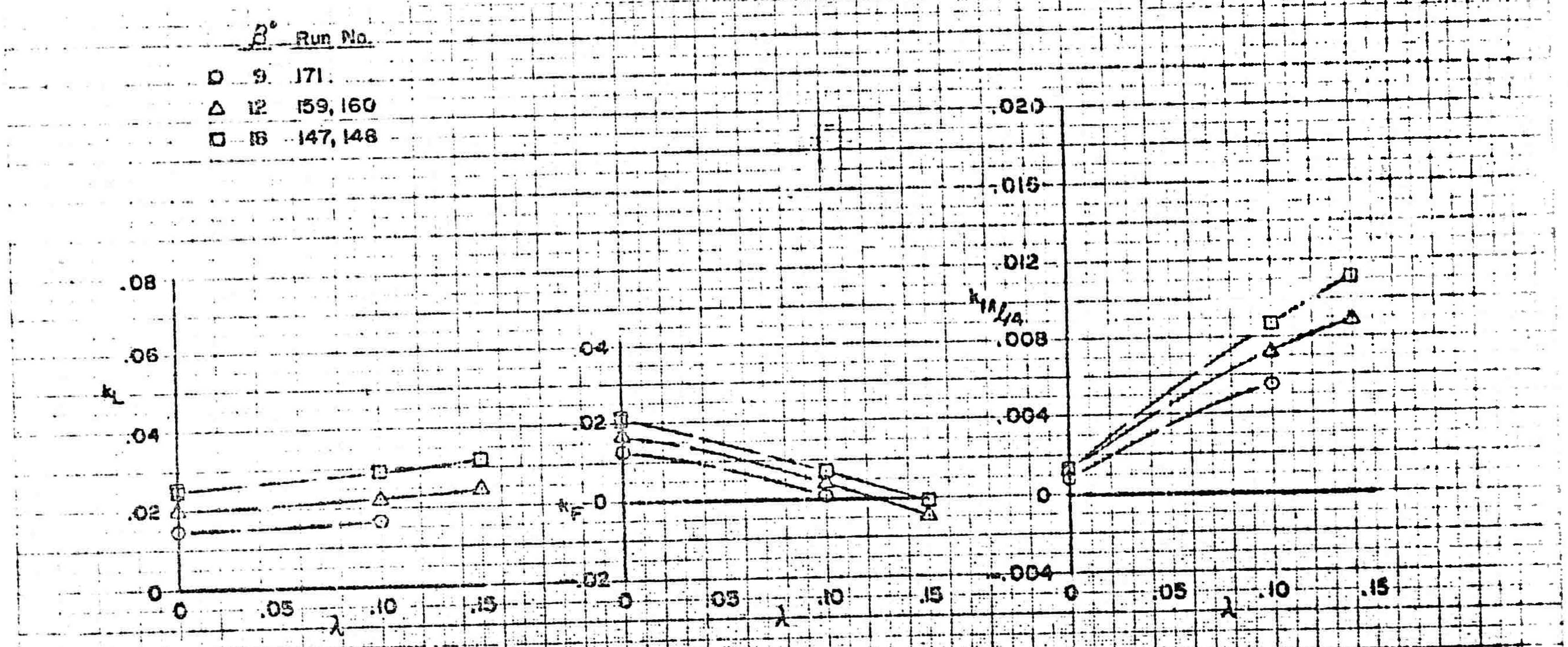

FIGURE 156 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3HB

$\alpha = 10^\circ$

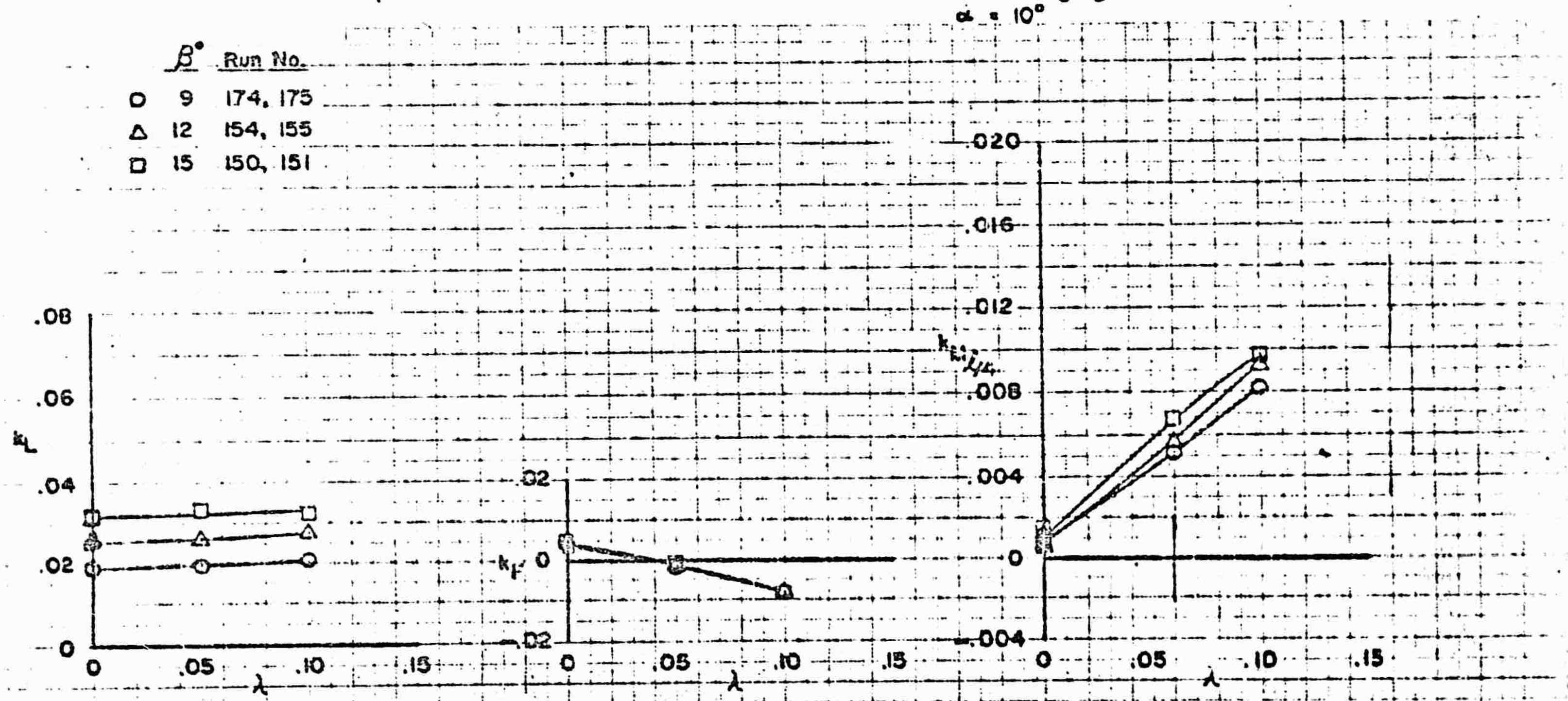

FIGURE 157 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

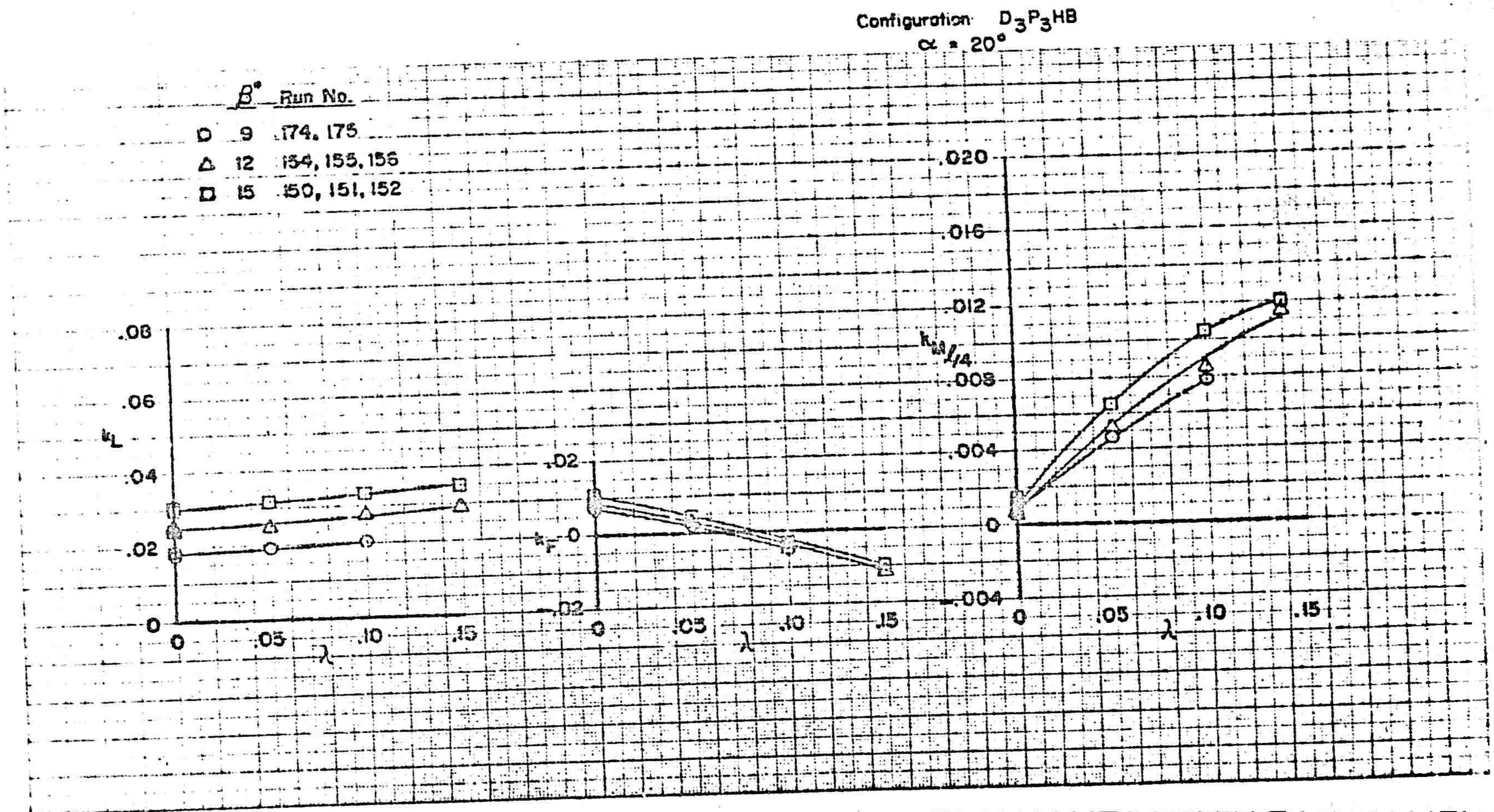

FIGURE 158 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

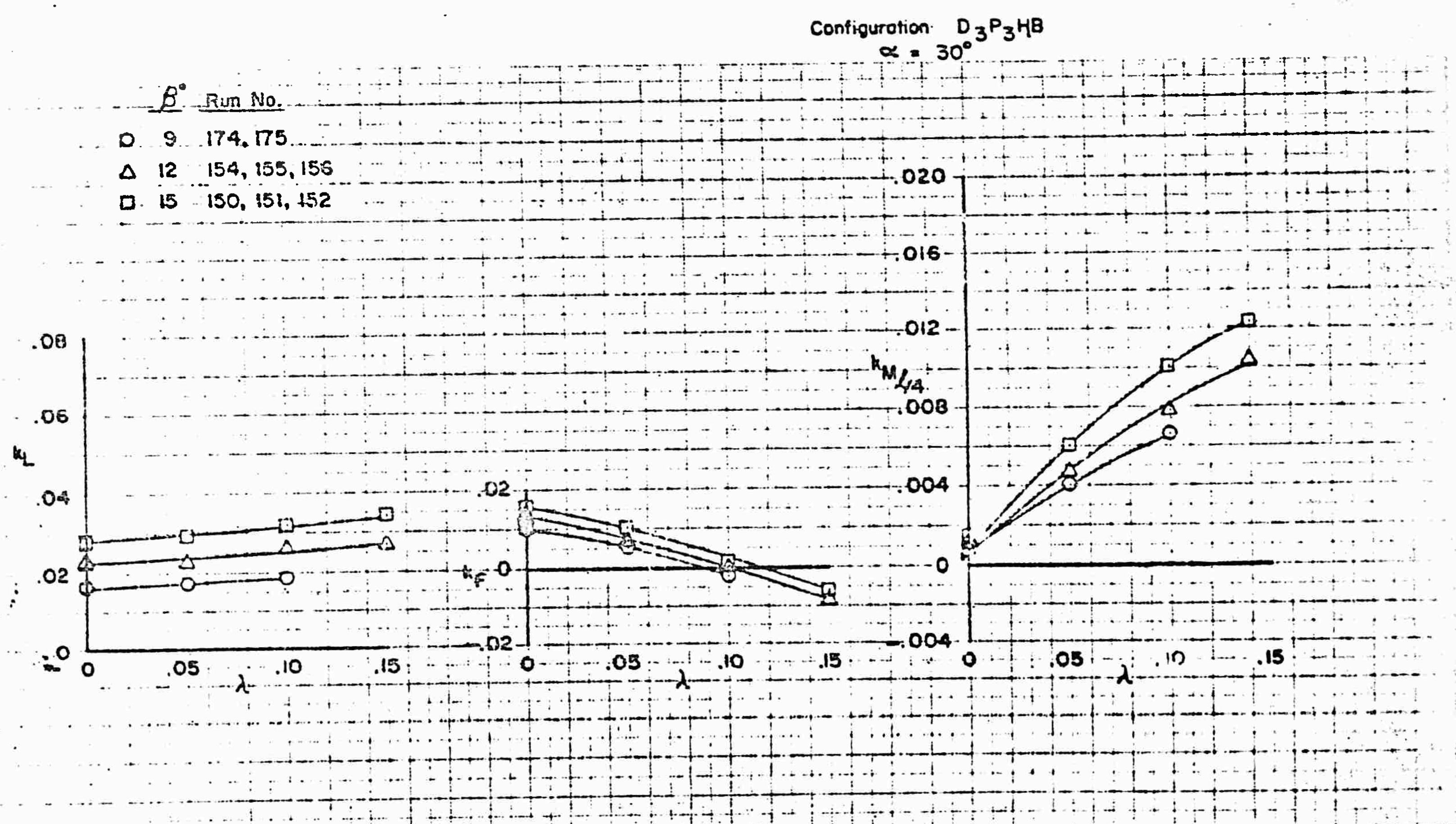

FIGURE 159 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3HB
$\alpha = 40°$

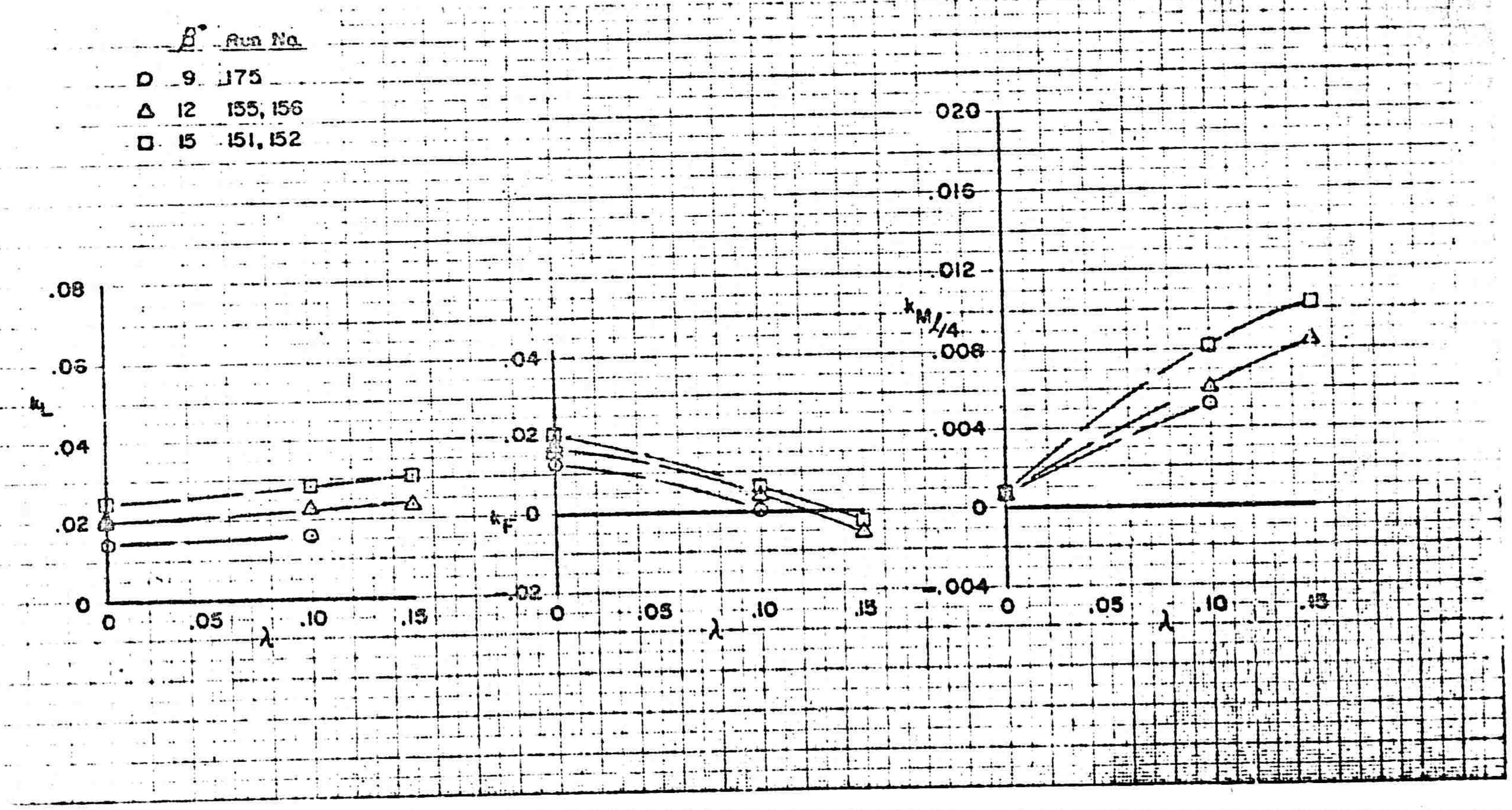

FIGURE 160 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

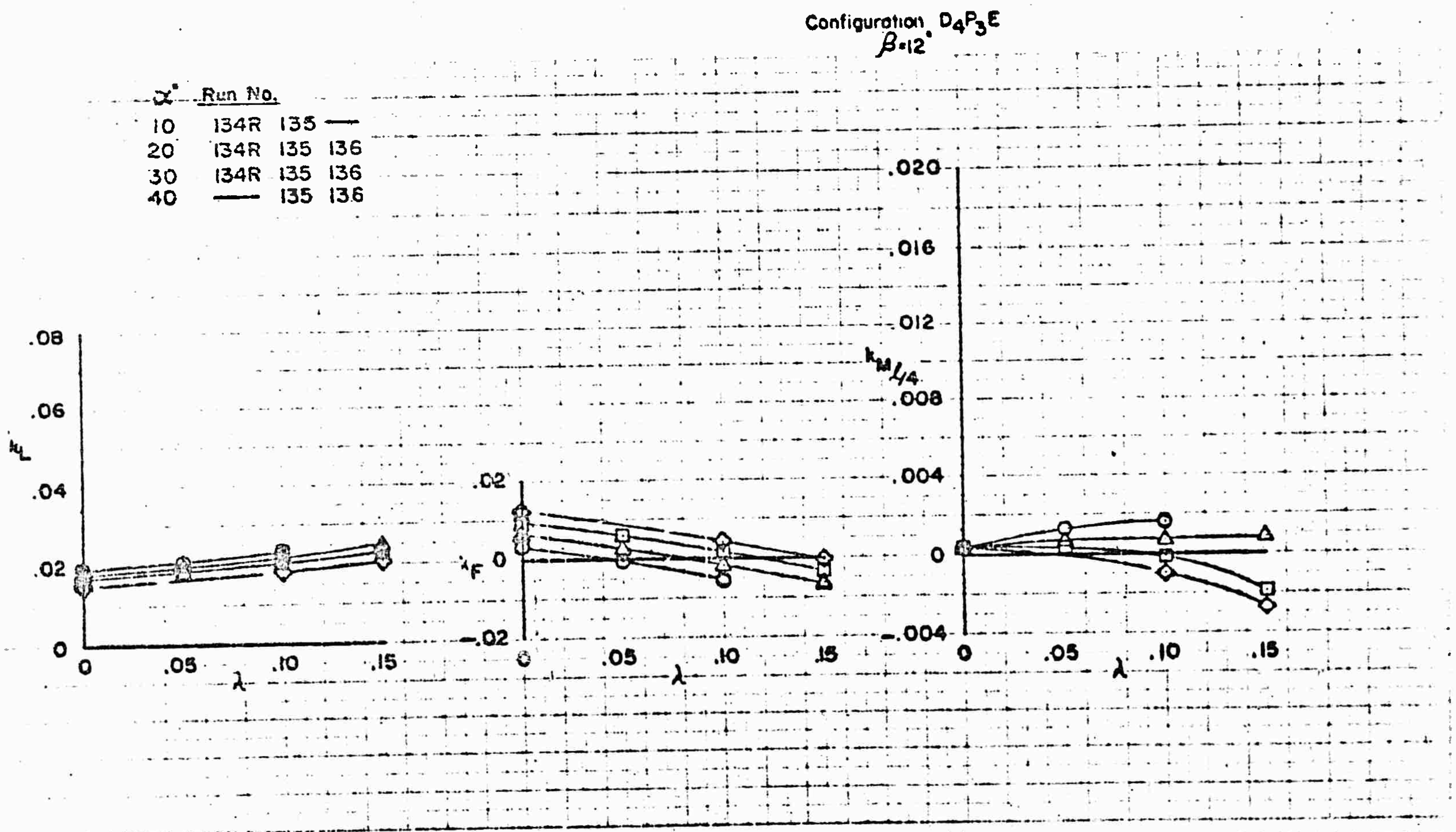

FIGURE 161 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3HE
$\beta^\circ = 12$

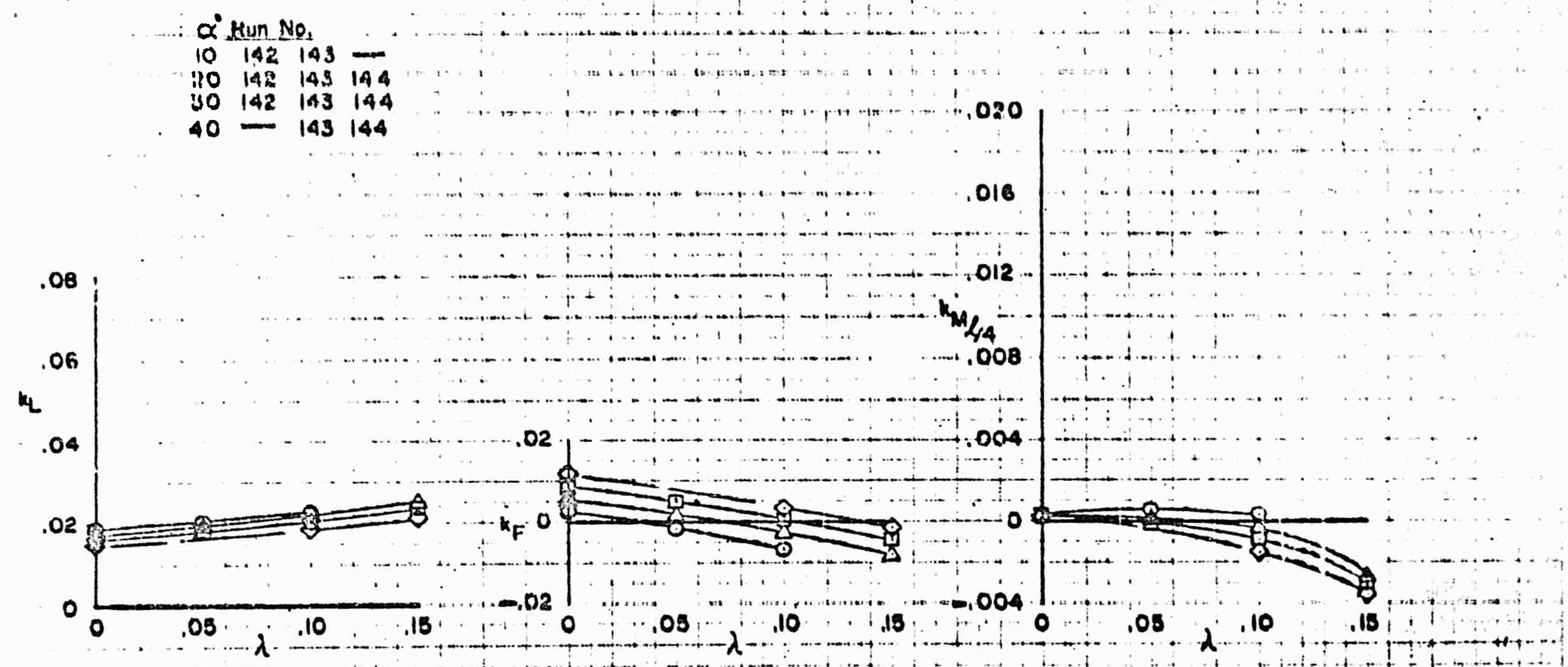

FIGURE 162 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S $\alpha = 10°$

$\Delta R = .088$
$\ell_p = 5.13$

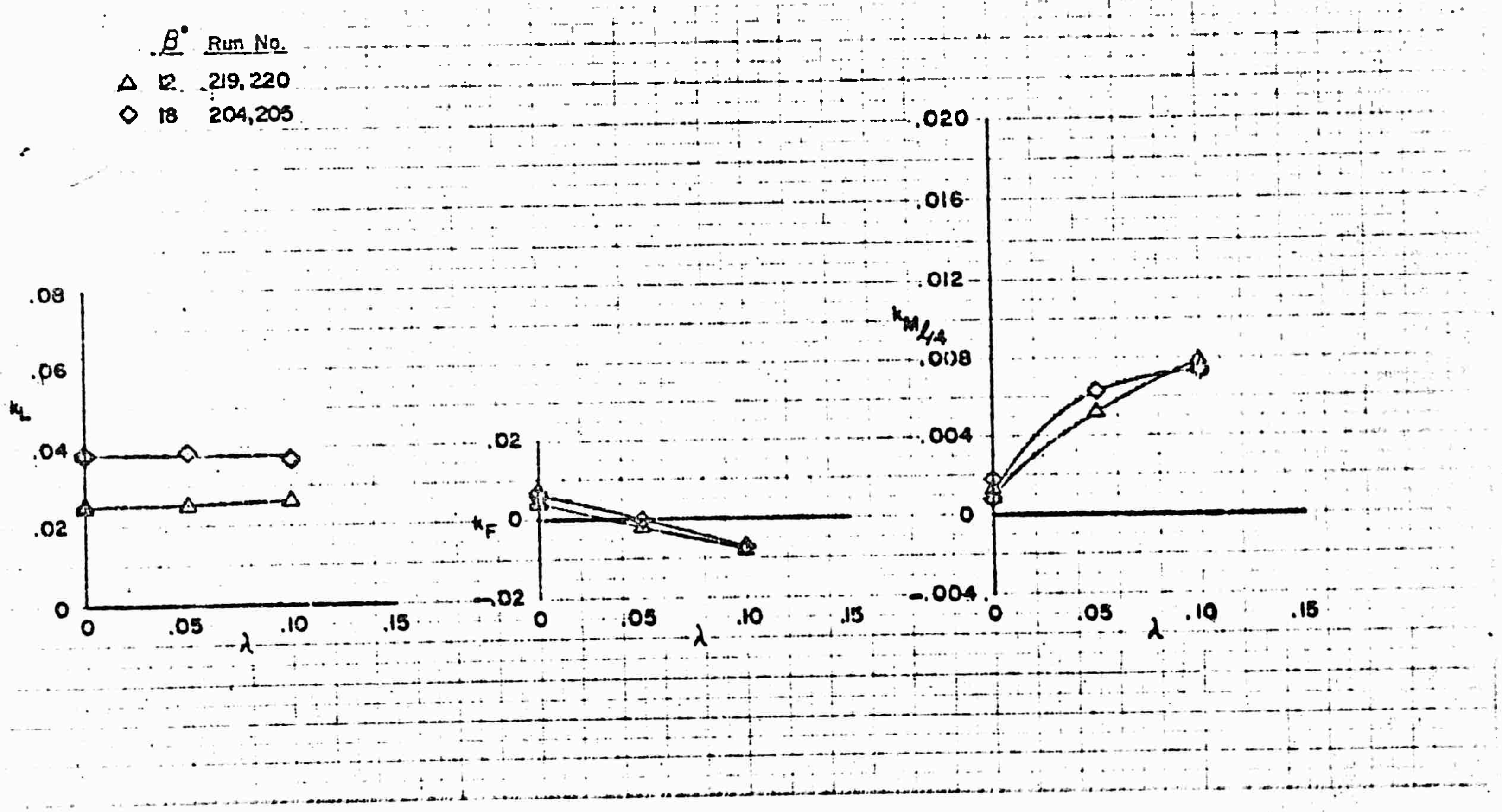

FIGURE 163 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S ΔR = 088

α = 20° ℓ_p = 513

	$\beta°$	Run No.
△	12	219, 220, 221
◇	18	204, 205, 206

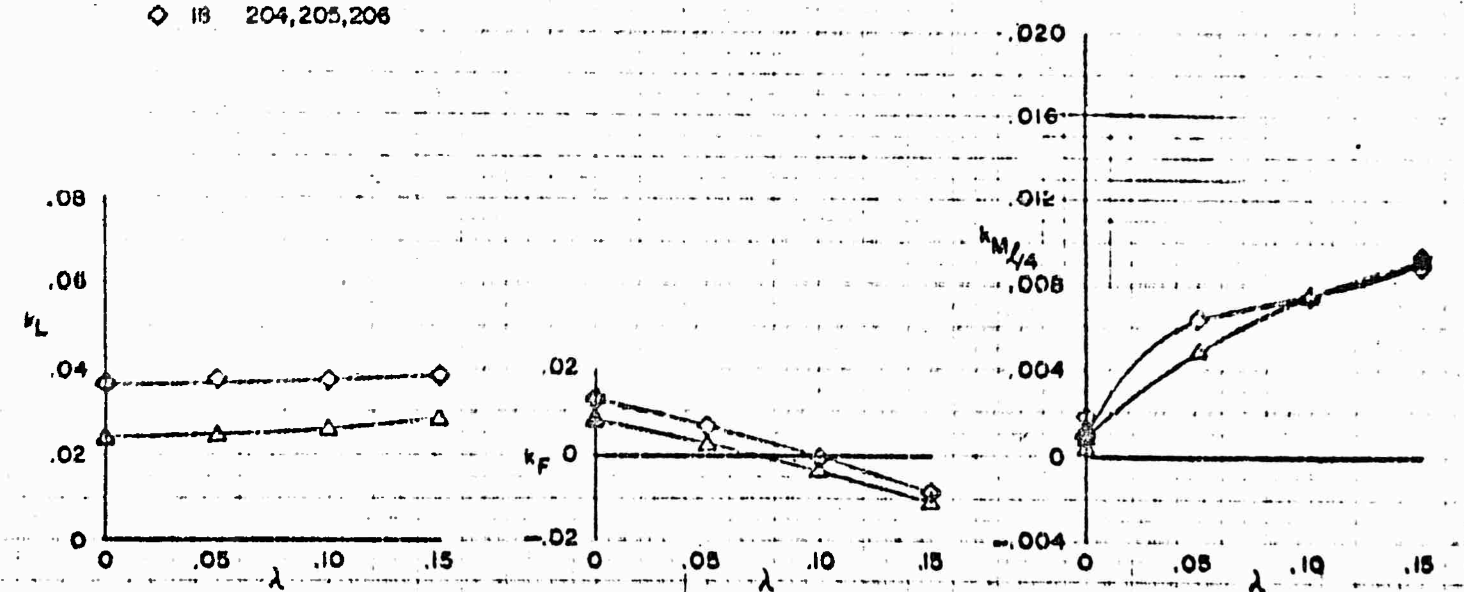

FIGURE 164 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

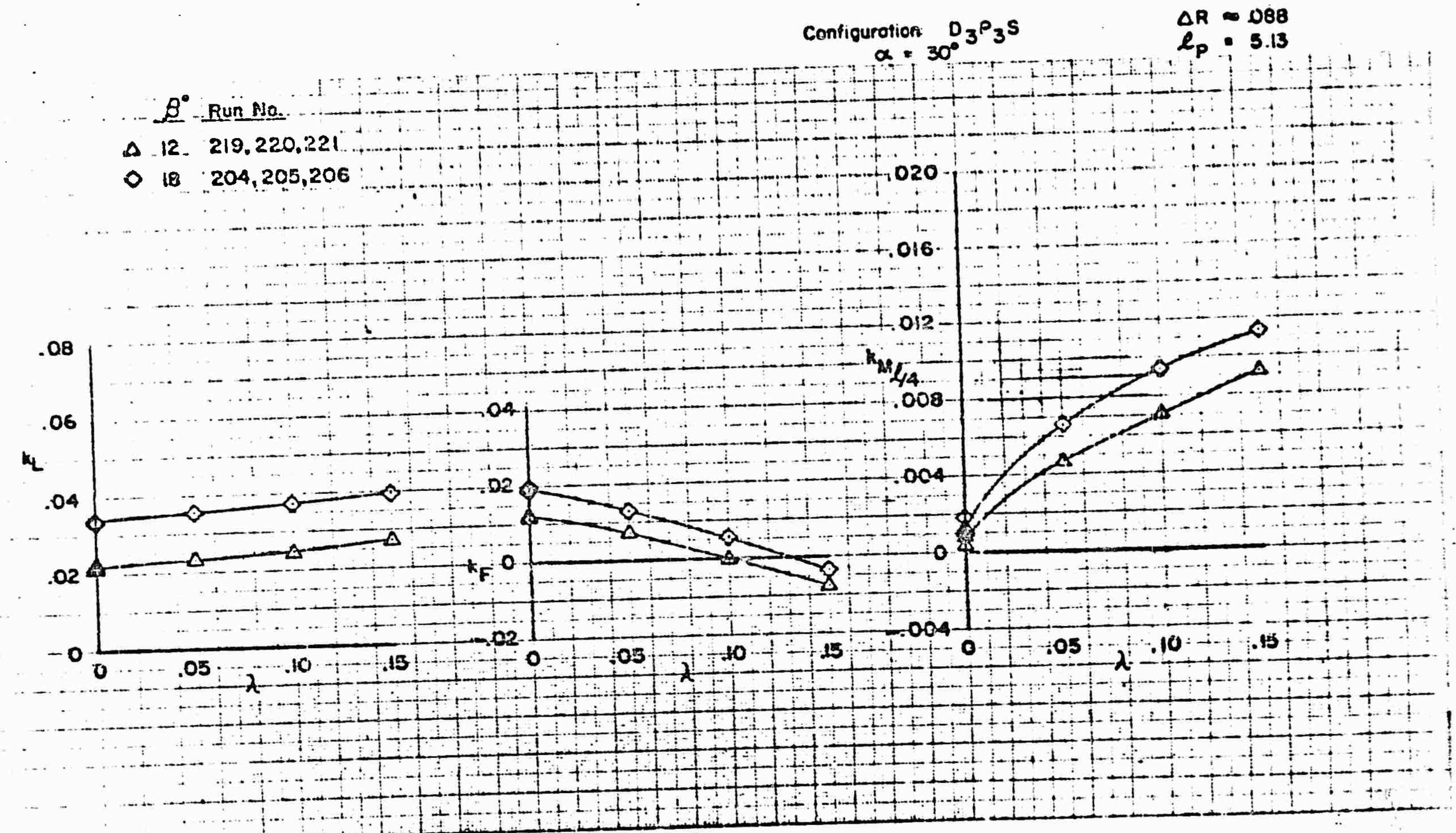

FIGURE 165 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S
$\alpha = 40°$

$\Delta R = .088$
$\ell_p = 5.13$

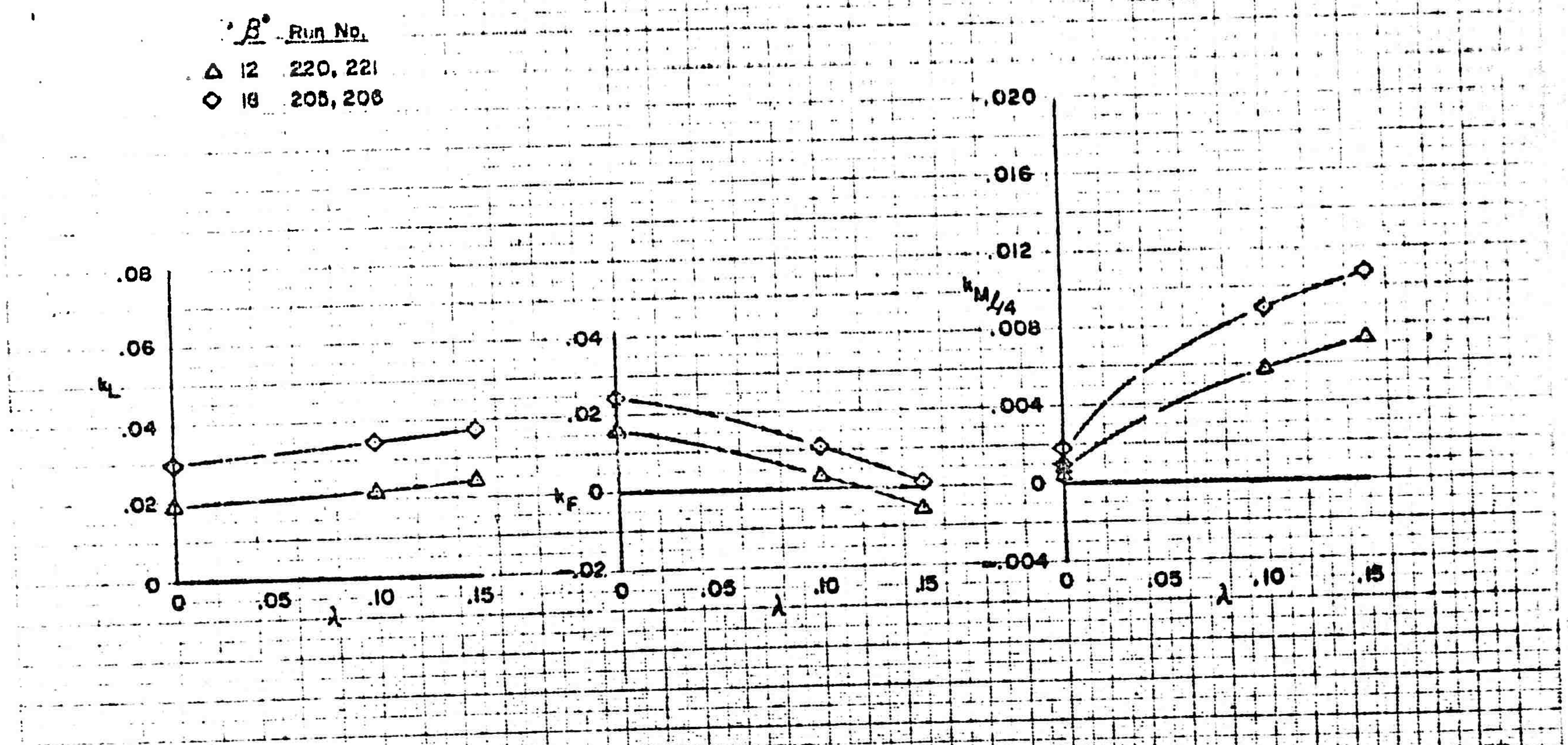

FIGURE 166 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr. 1357 (00) Phase IV

Configuration: D_3P_3S $\Delta R = .046$

$\alpha = 10°$ $\ell_P = 4.08$

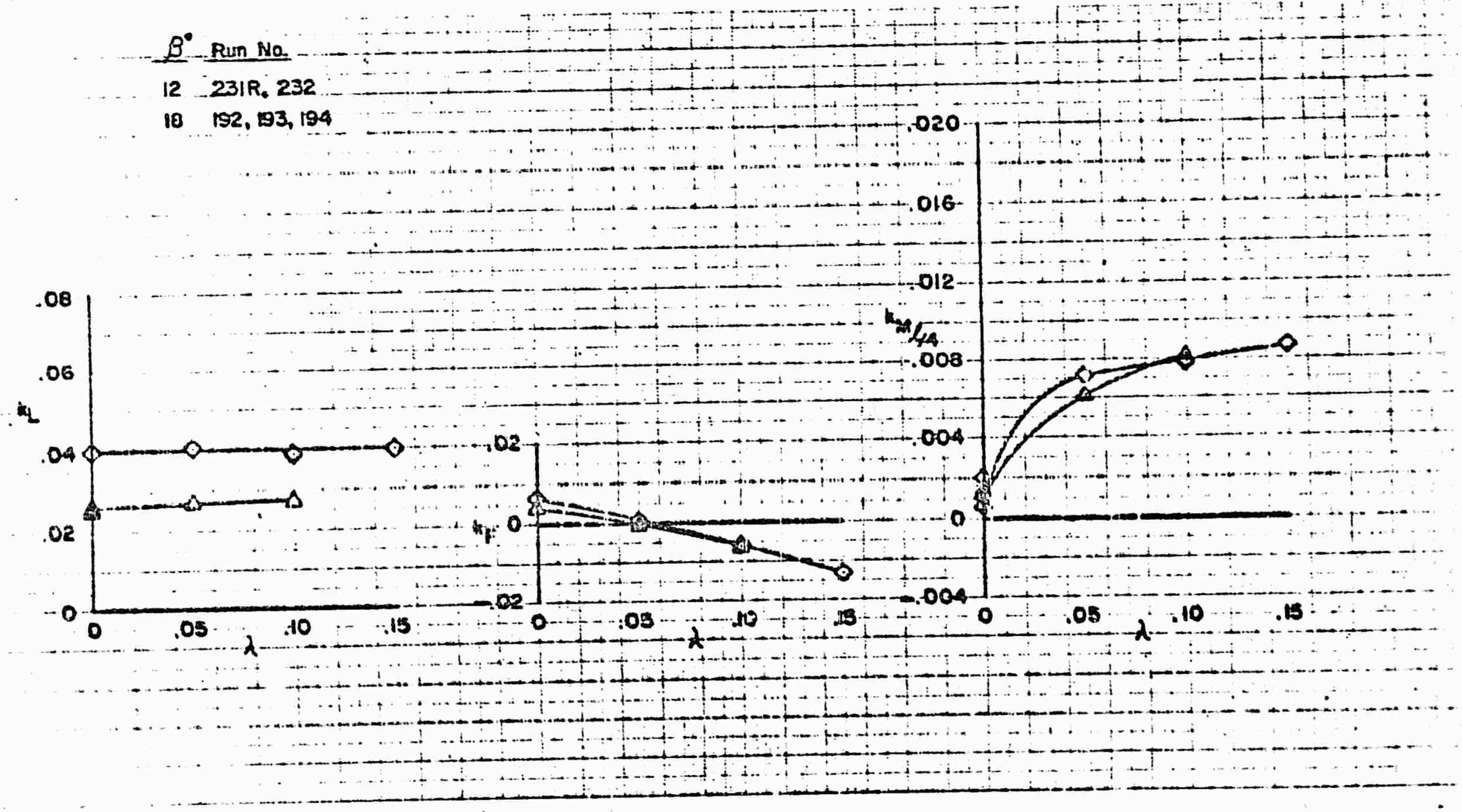

FIGURE 167 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S $\Delta R = .046$

$\alpha = 20°$ $\ell_p = 4.08$

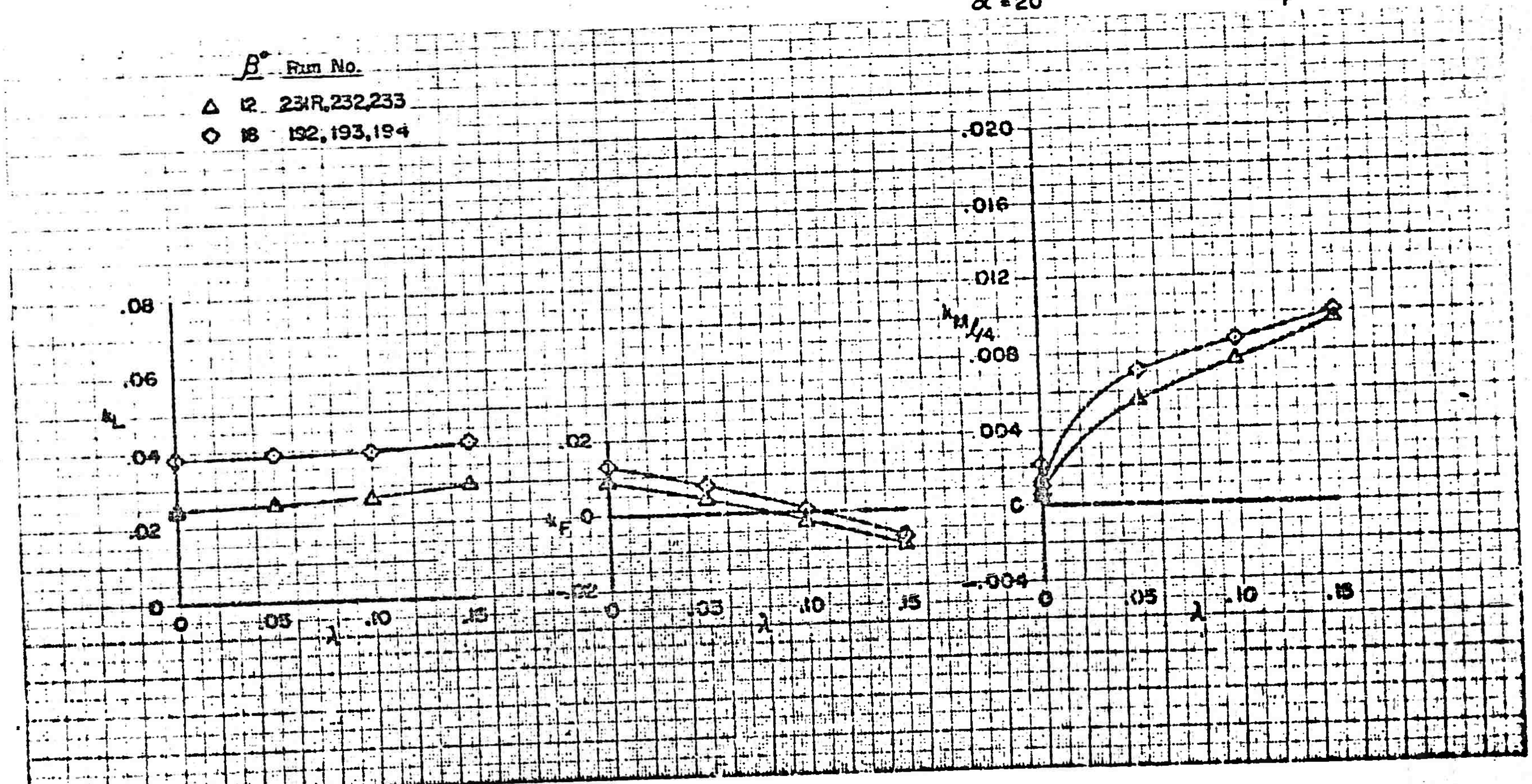

FIGURE 168 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S $\Delta R = .046$

$\alpha = 30°$ $\ell_p = 4.08$

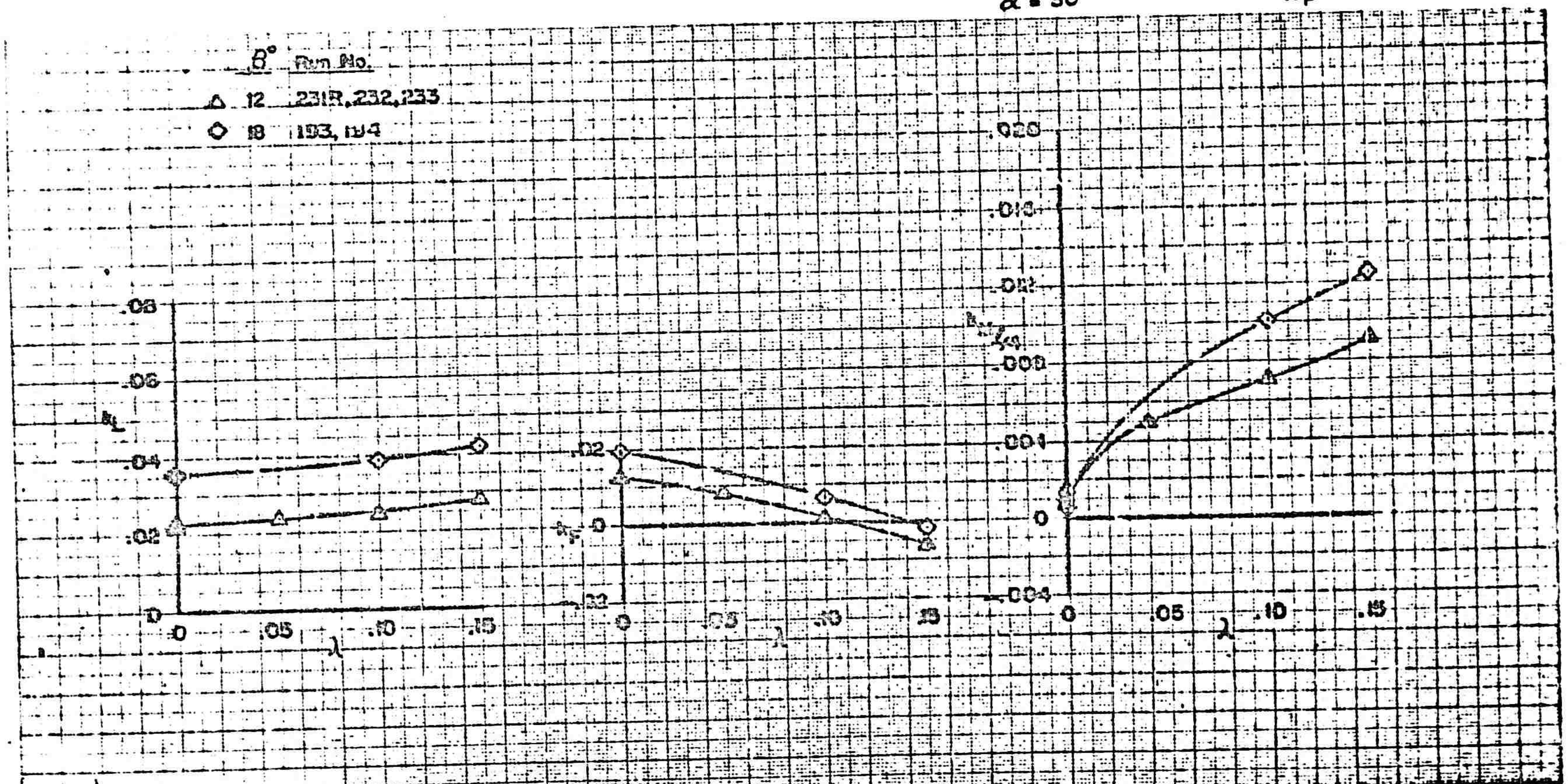

FIGURE 169 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S $\Delta R = .046$

$\alpha = 40°$ $\ell_p = 4.08$

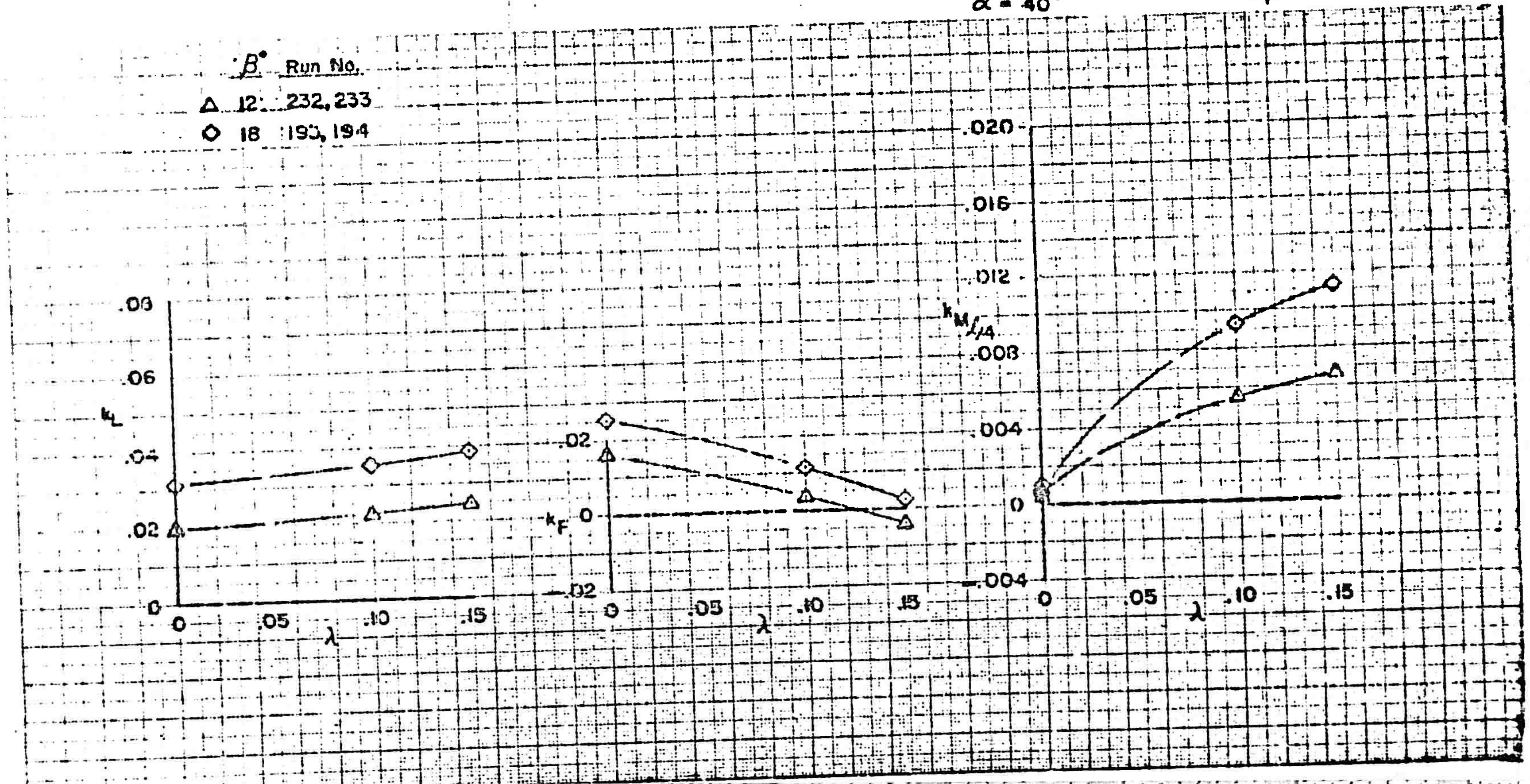

FIGURE 170 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S $\alpha = 10°$

$\Delta R = .088$
$\ell_p = .408$

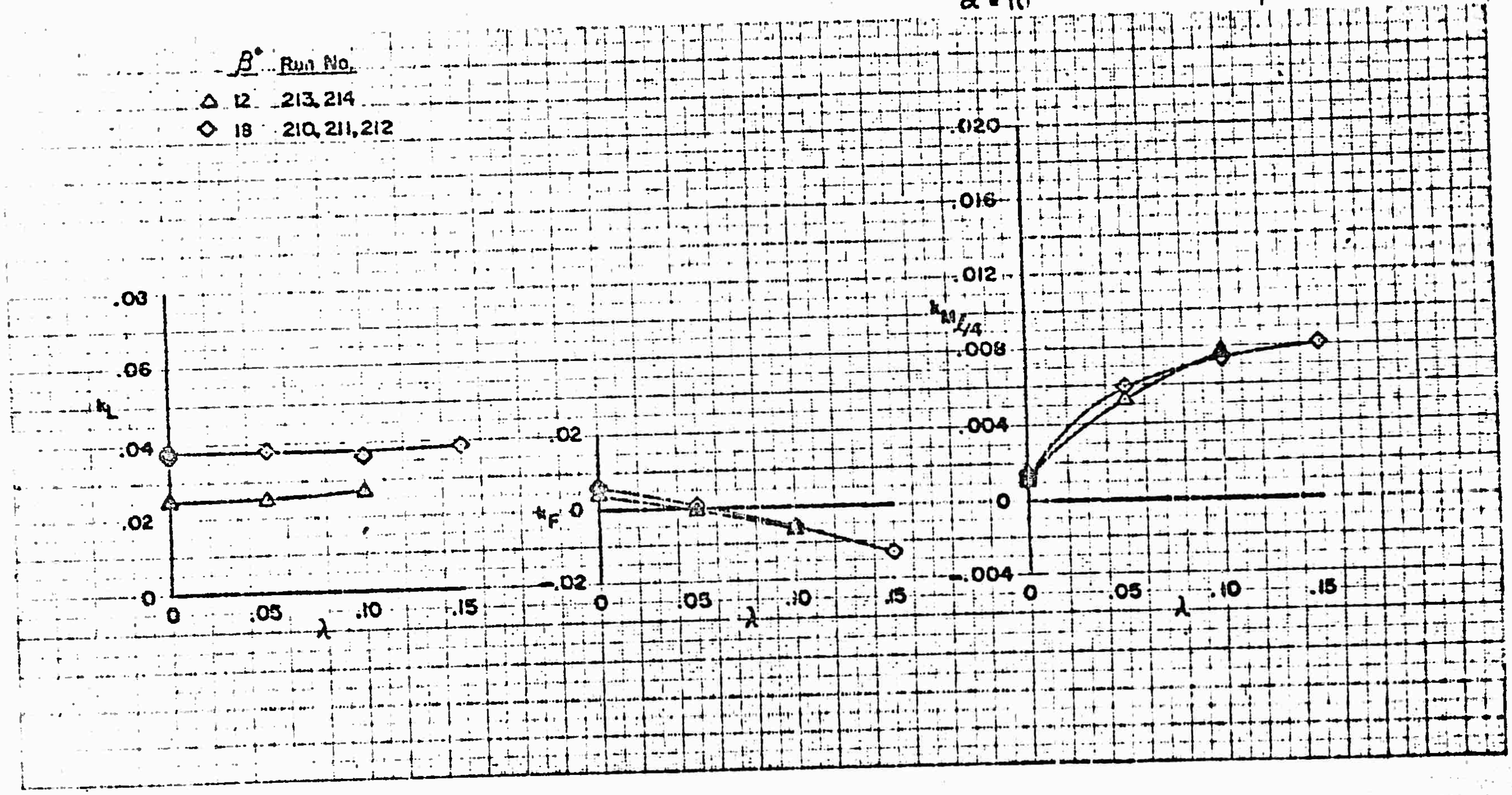

FIGURE 171 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S $\Delta R = .088$

$\alpha = 20°$ $\ell_p = 4.08$

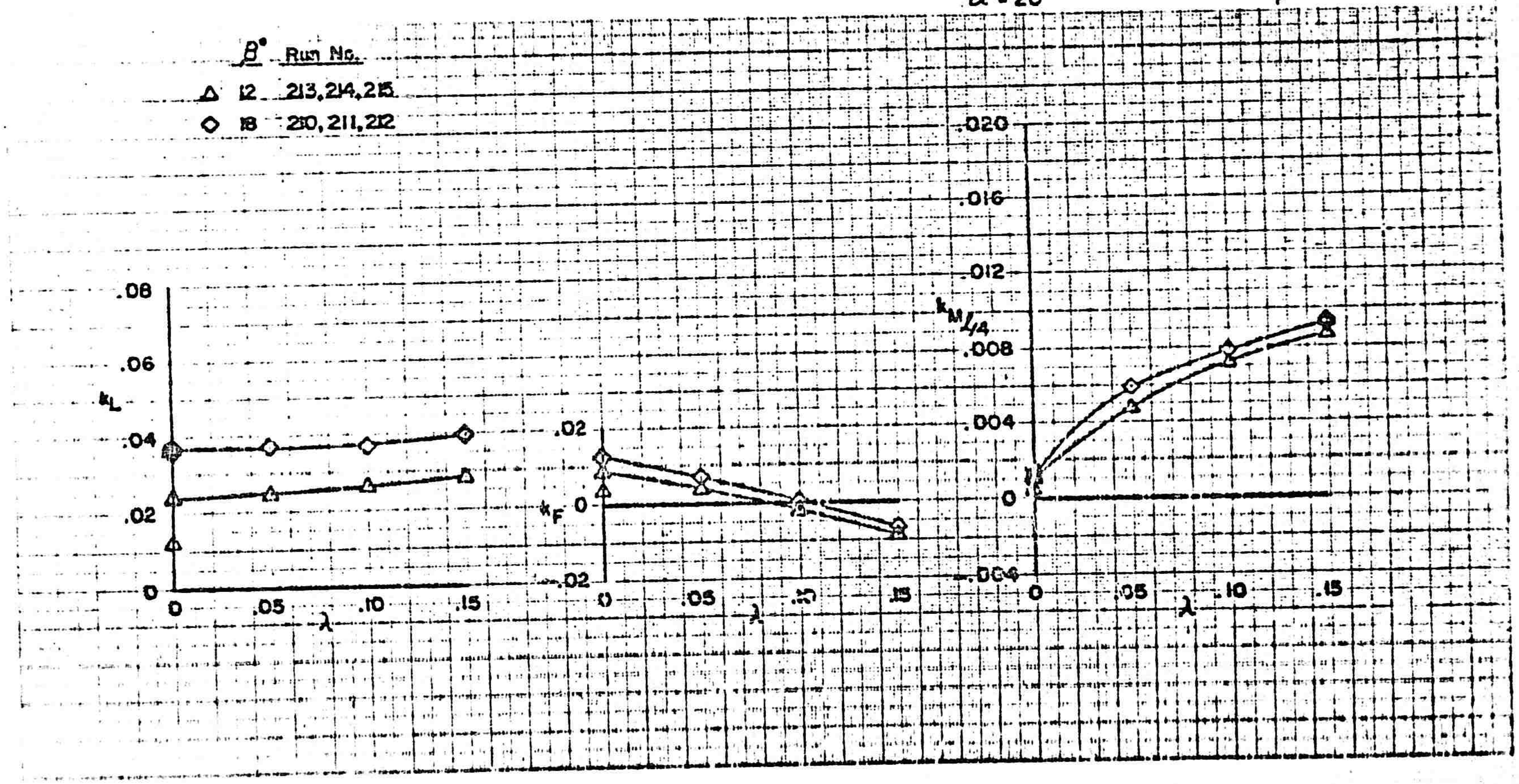

FIGURE 172 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1387 (00) Phase IV

Configuration: D_3P_3S

$\alpha = 30°$

$\Delta R = .080$

$\ell_P = 4.08$

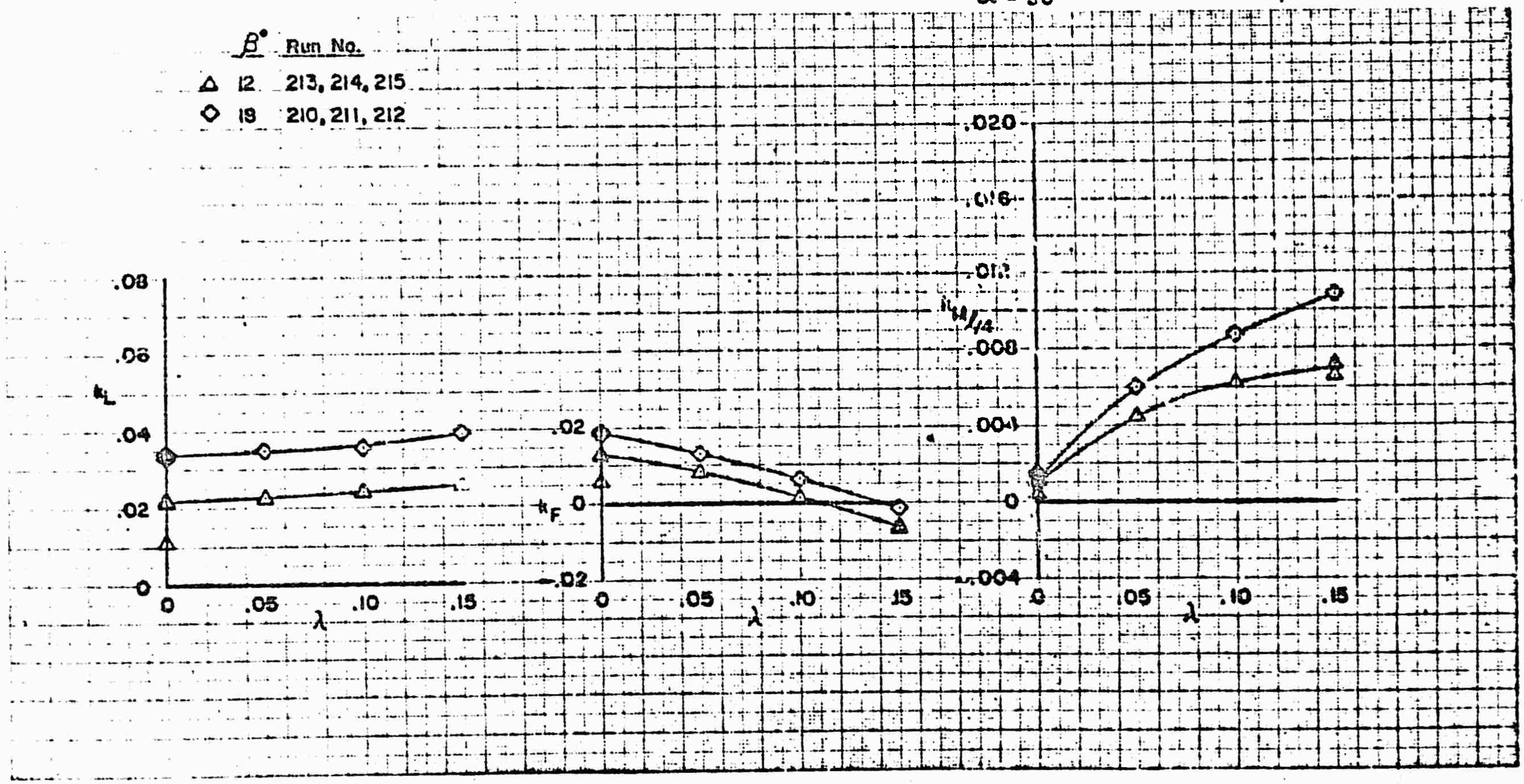

FIGURE 173 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

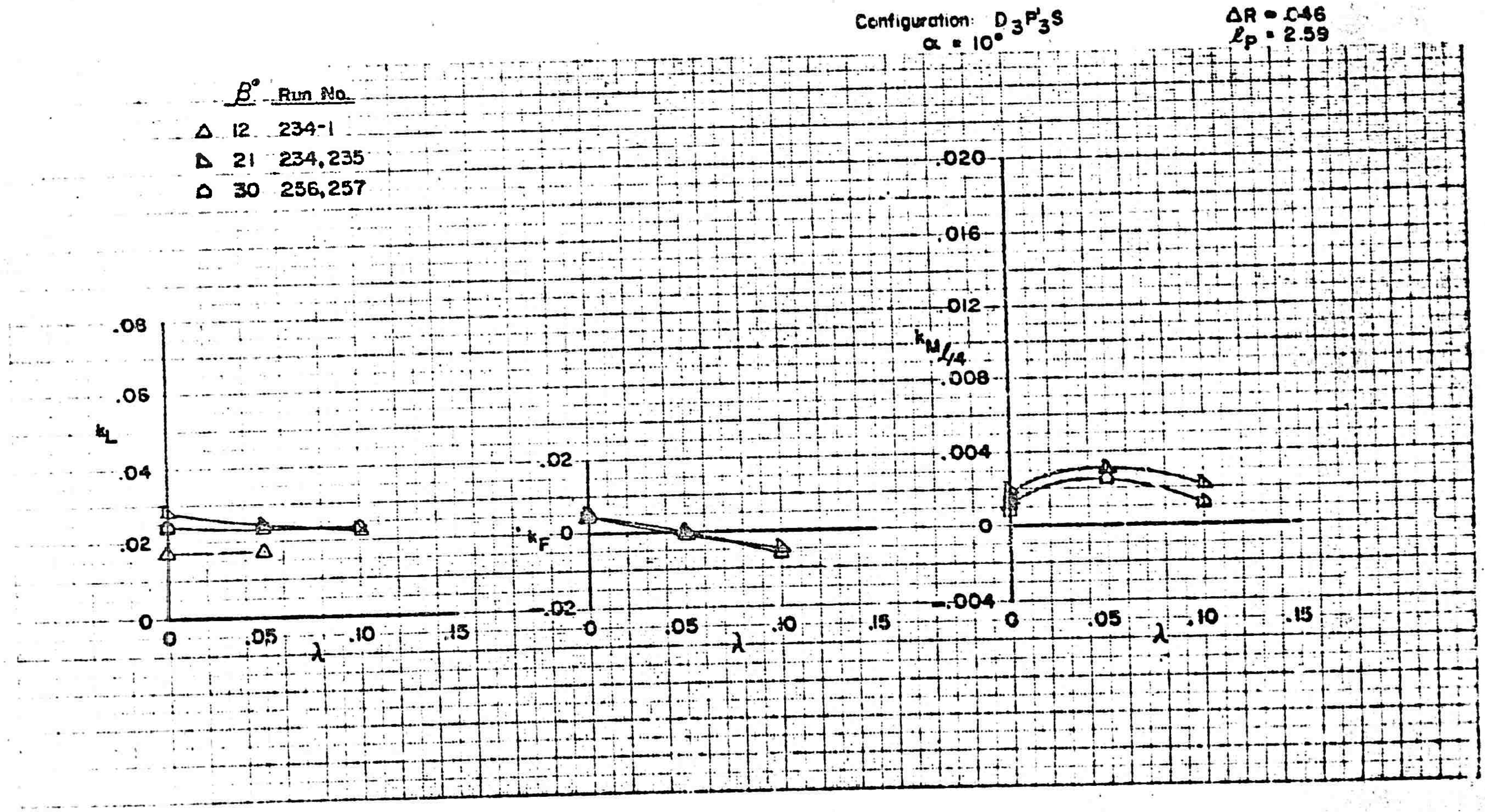

FIGURE 174 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3 P'_3 8$ $\alpha = 20°$ $\Delta R = .046$ $\ell_p = 2.59$

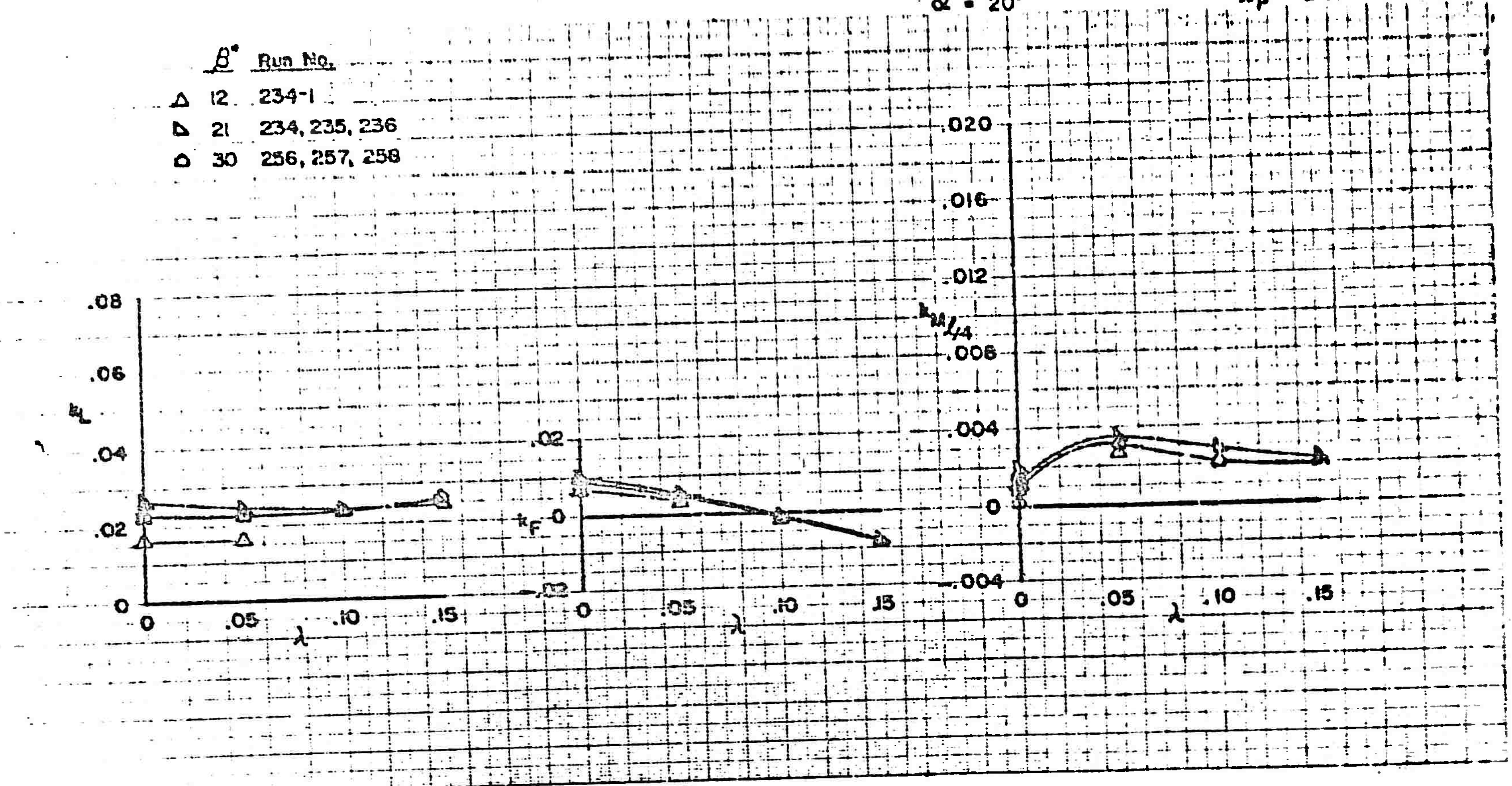

FIGURE 175 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

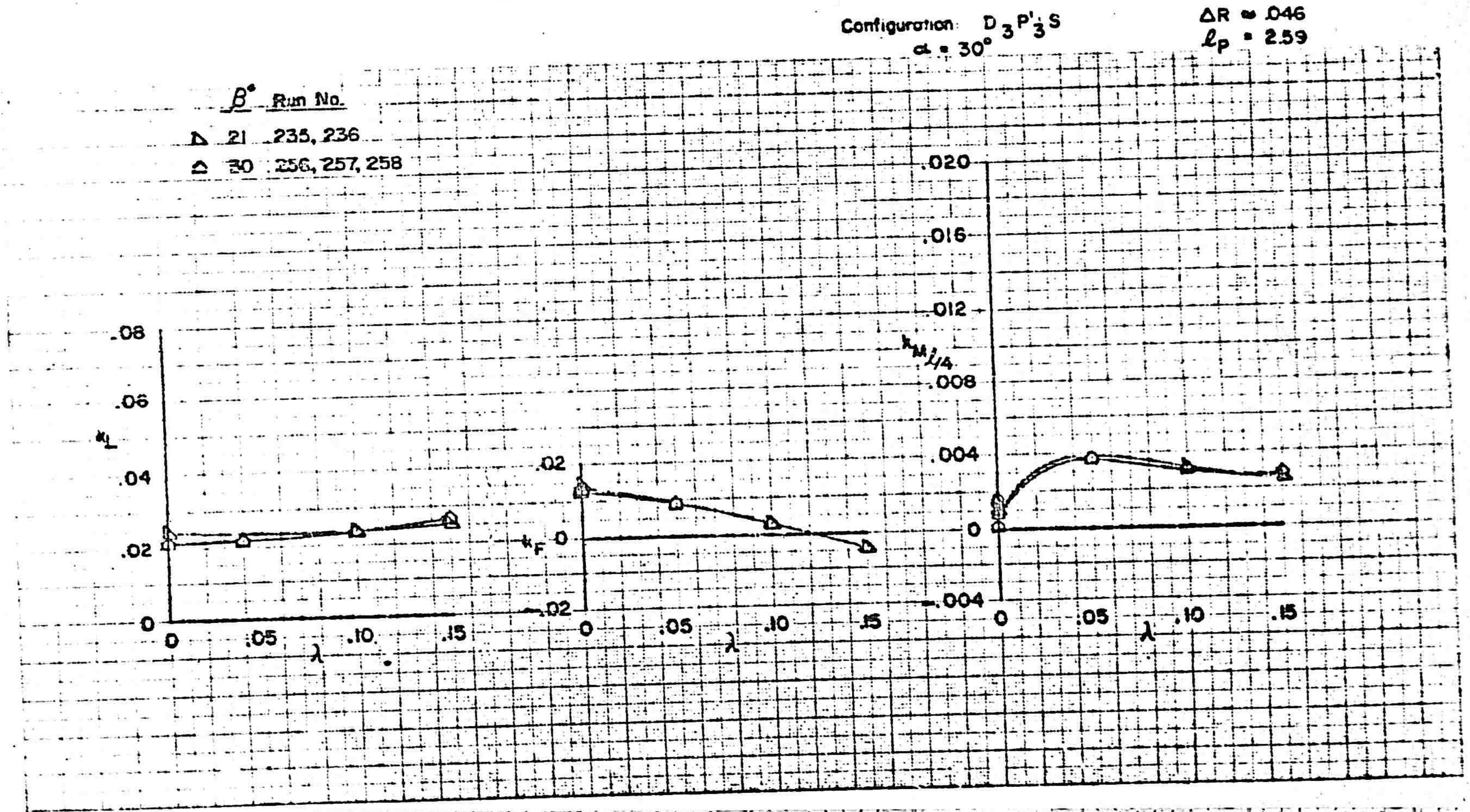

FIGURE 176 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P'_3S$ $\Delta R = .046$

$\alpha = 40°$ $\ell_p = 2.59$

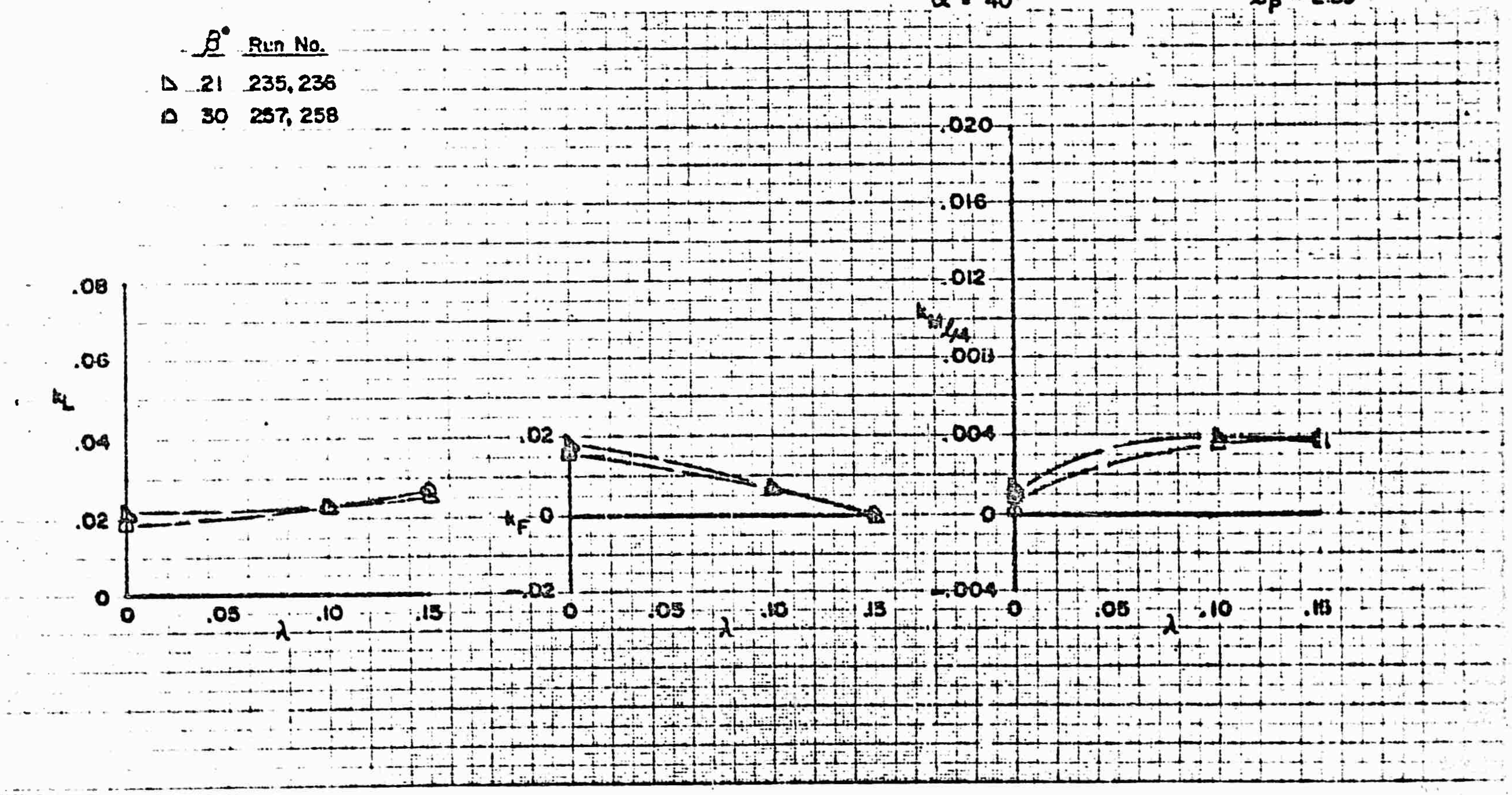

FIGURE 177 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

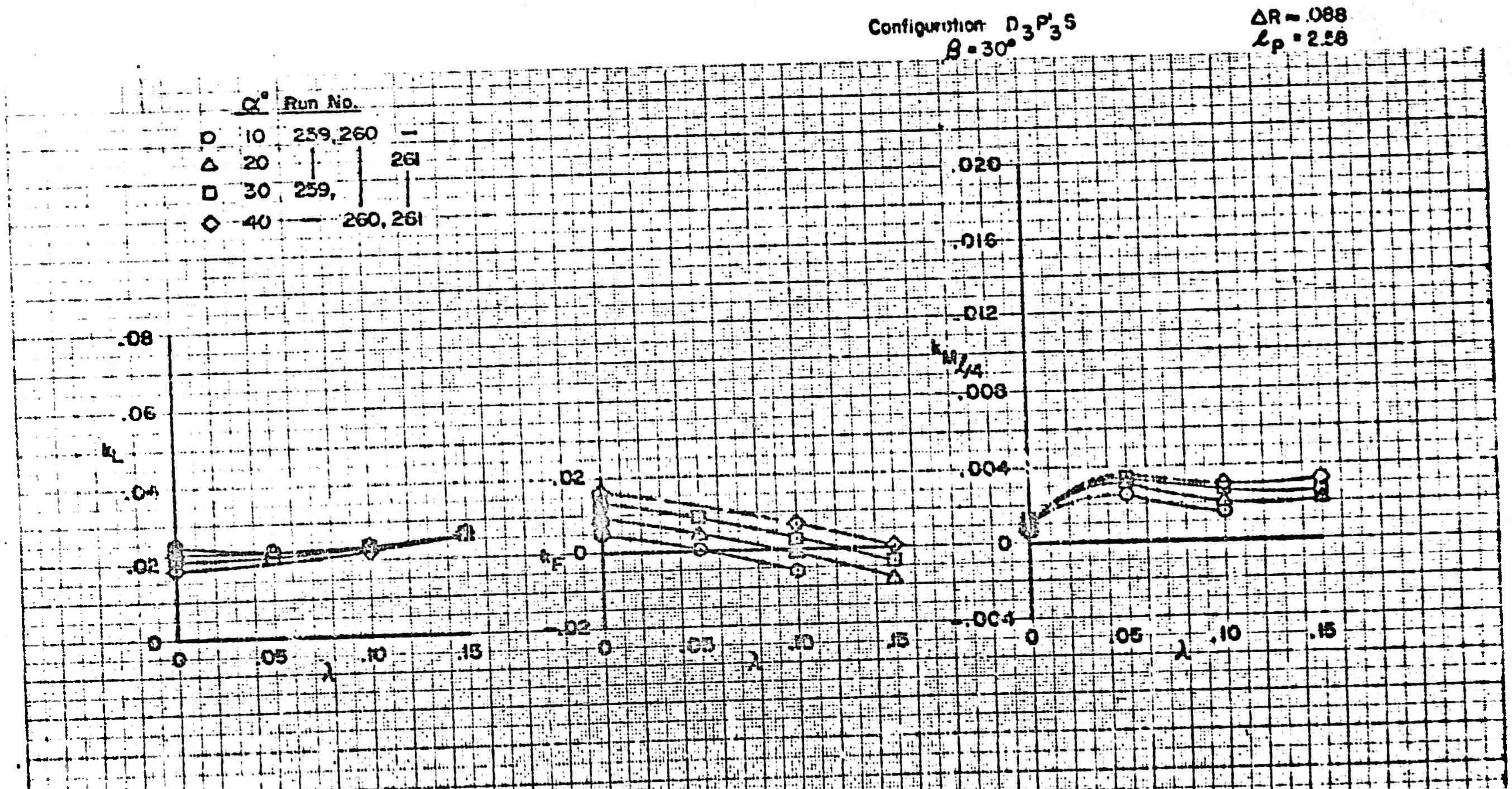

FIGURE 178 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

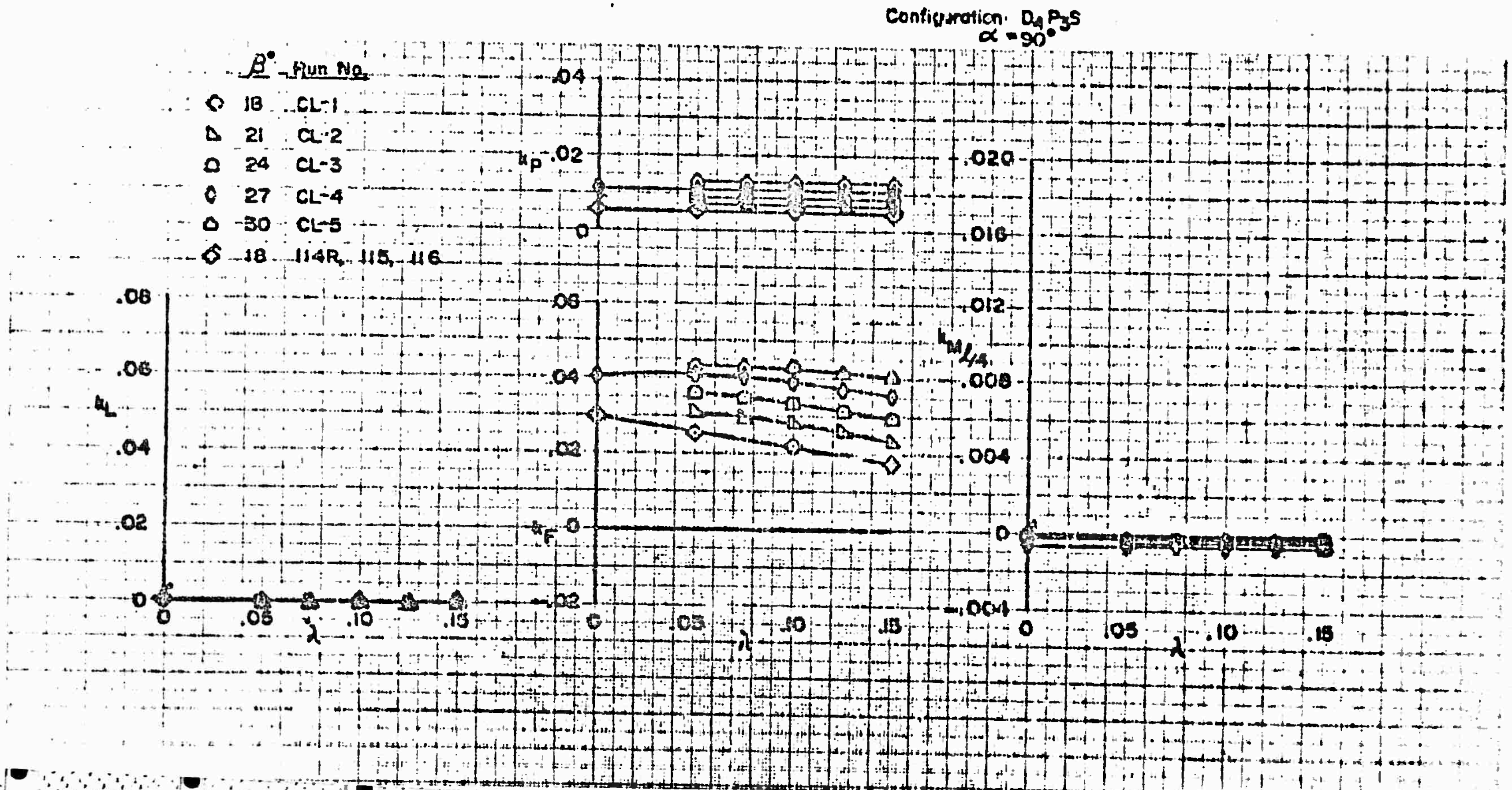

FIGURE 179 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

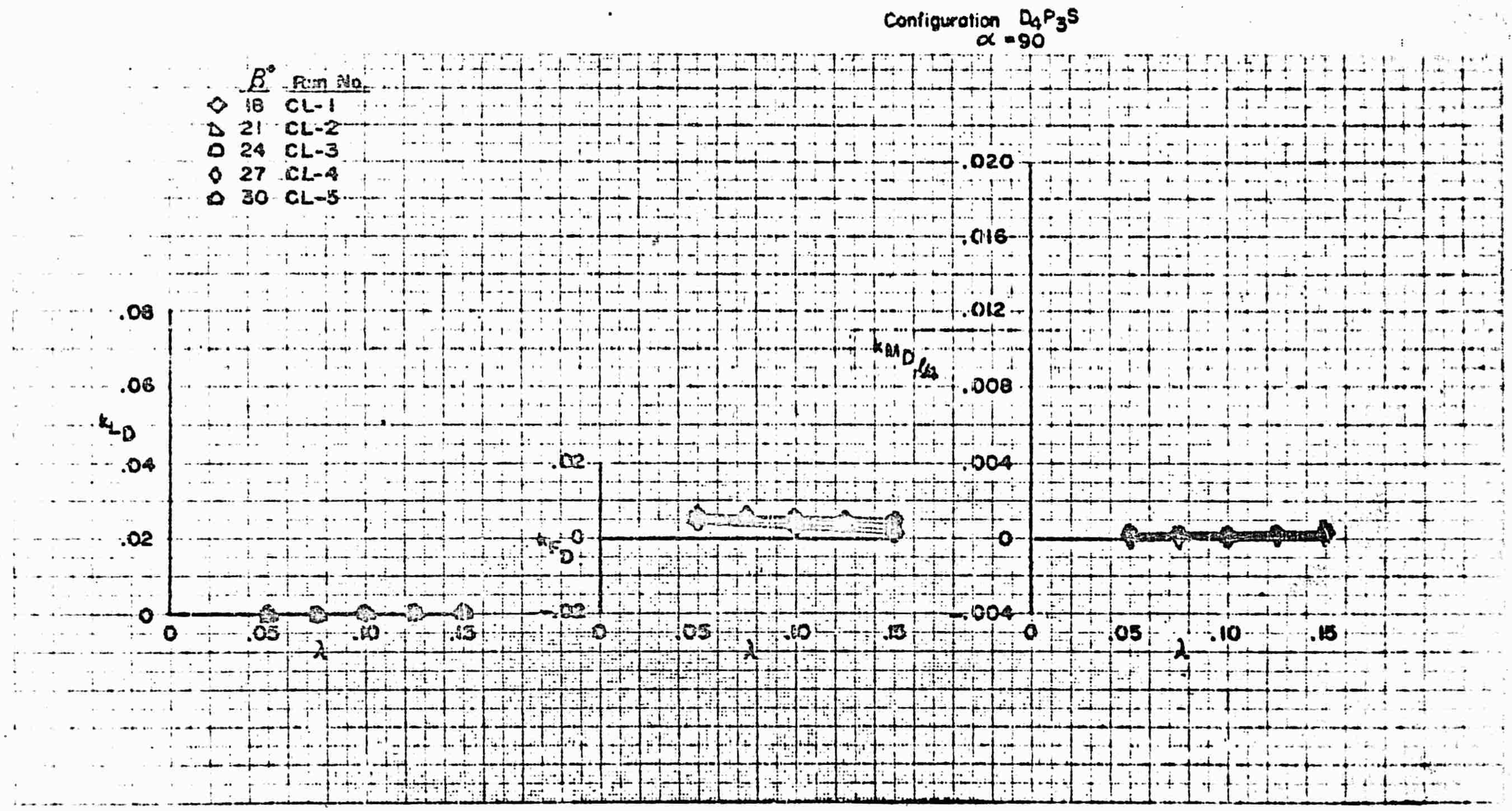

FIGURE 180 VARIATION OF DUCTED PROPELLER FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

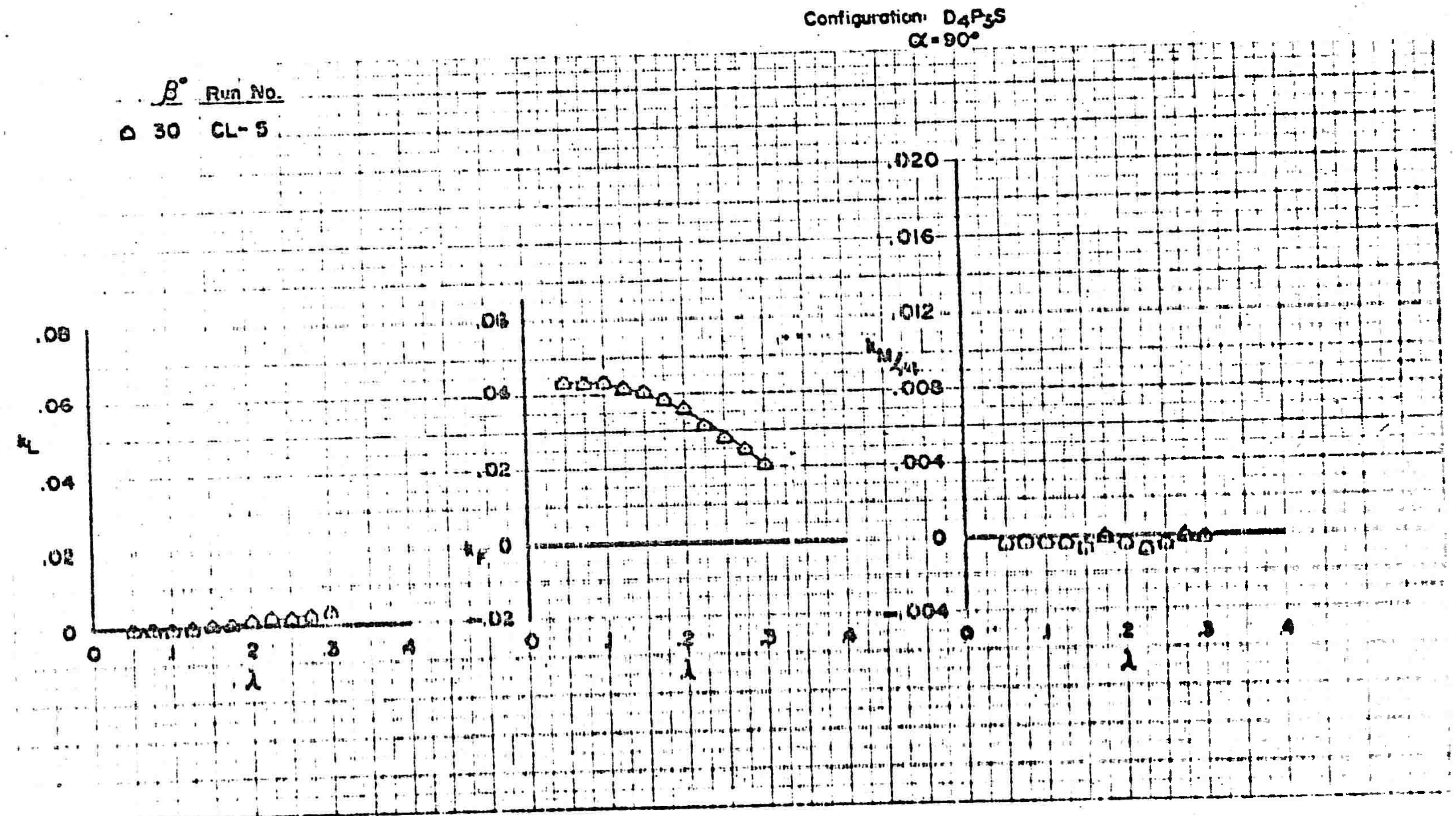

FIGURE 181 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH ADVANCE RATIO

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S

$\alpha = 90°$

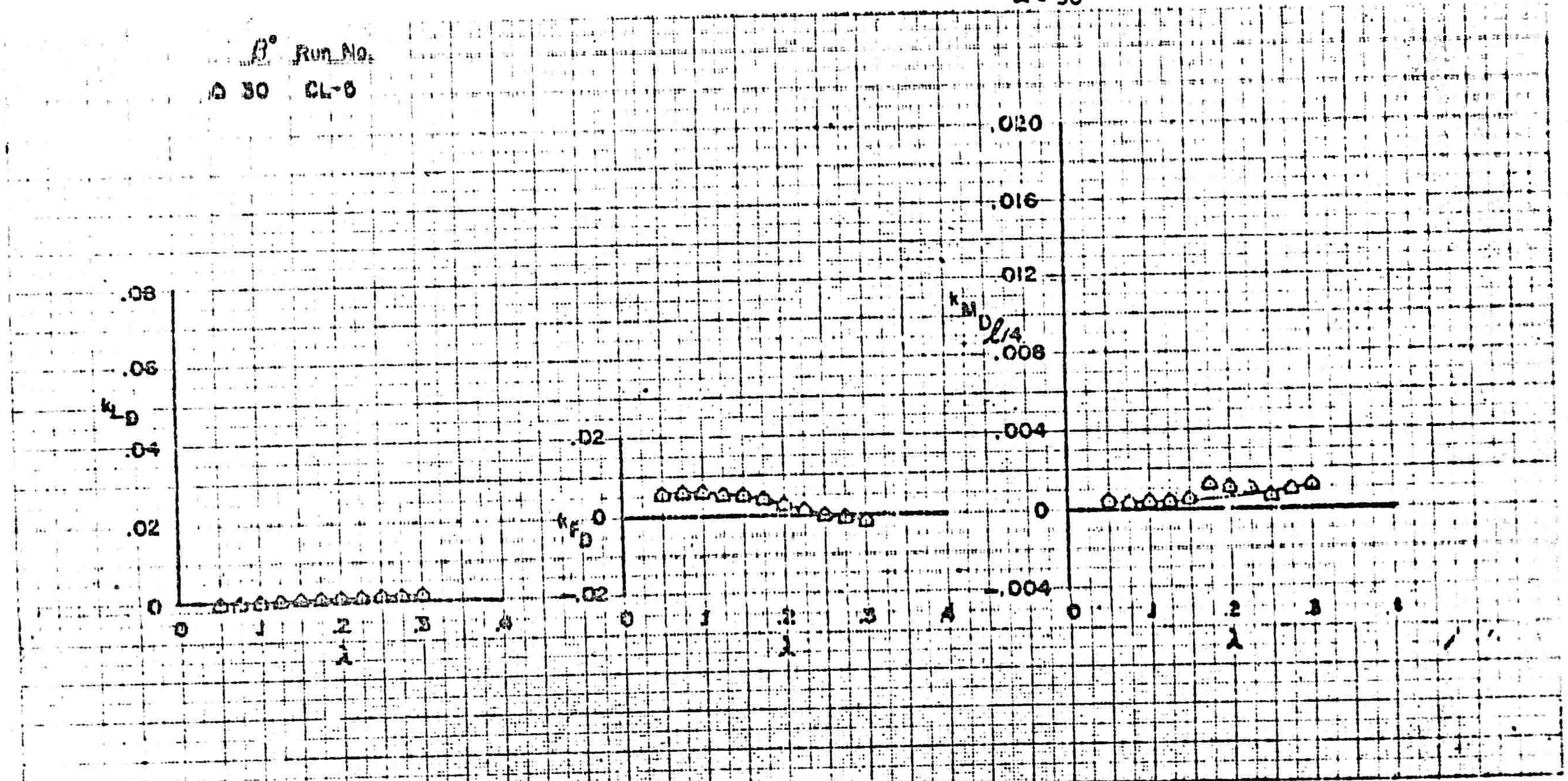

FIGURE 182 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

$\beta = 5°$

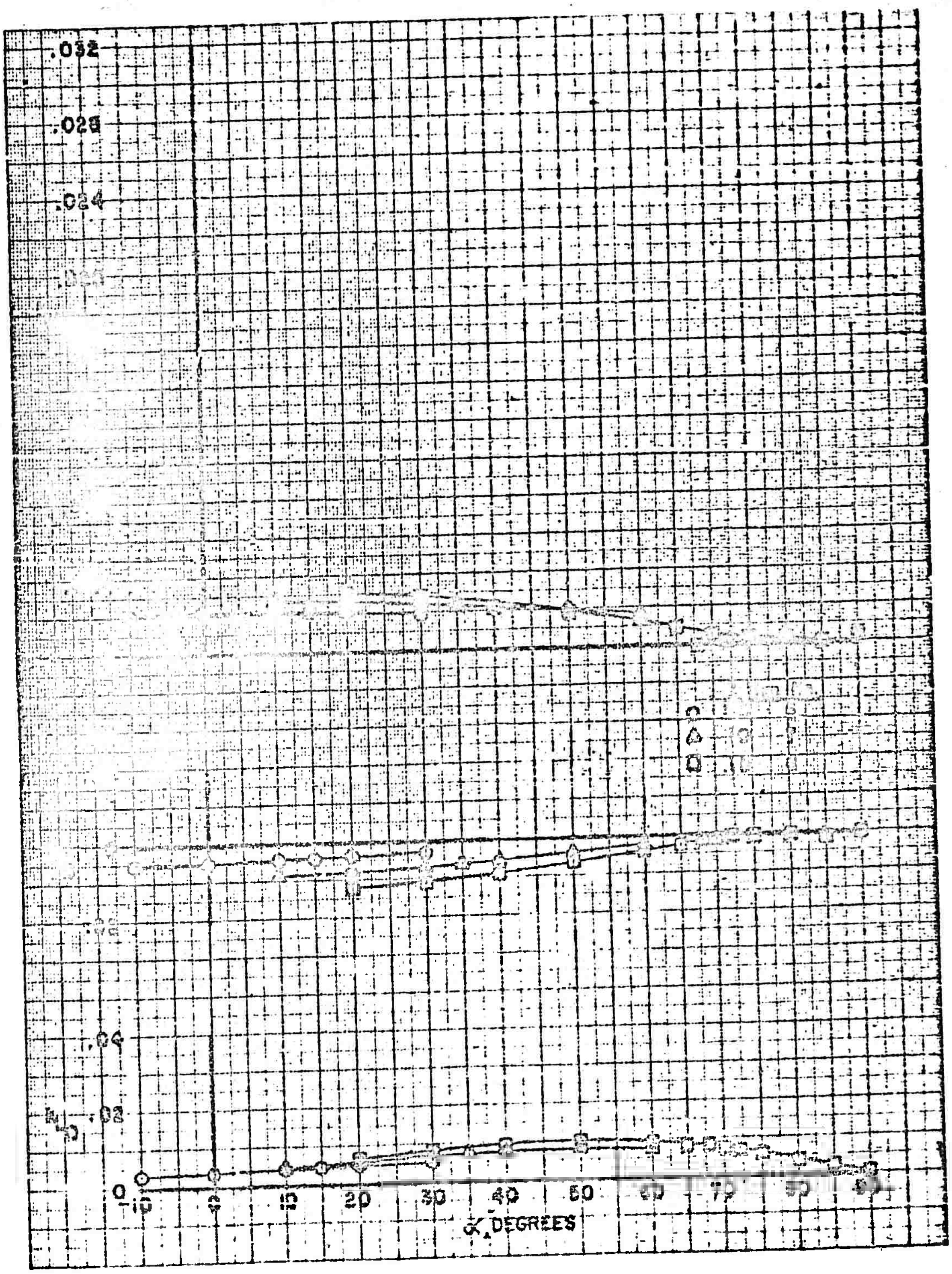

FIGURE 183 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

$\beta = 12°$

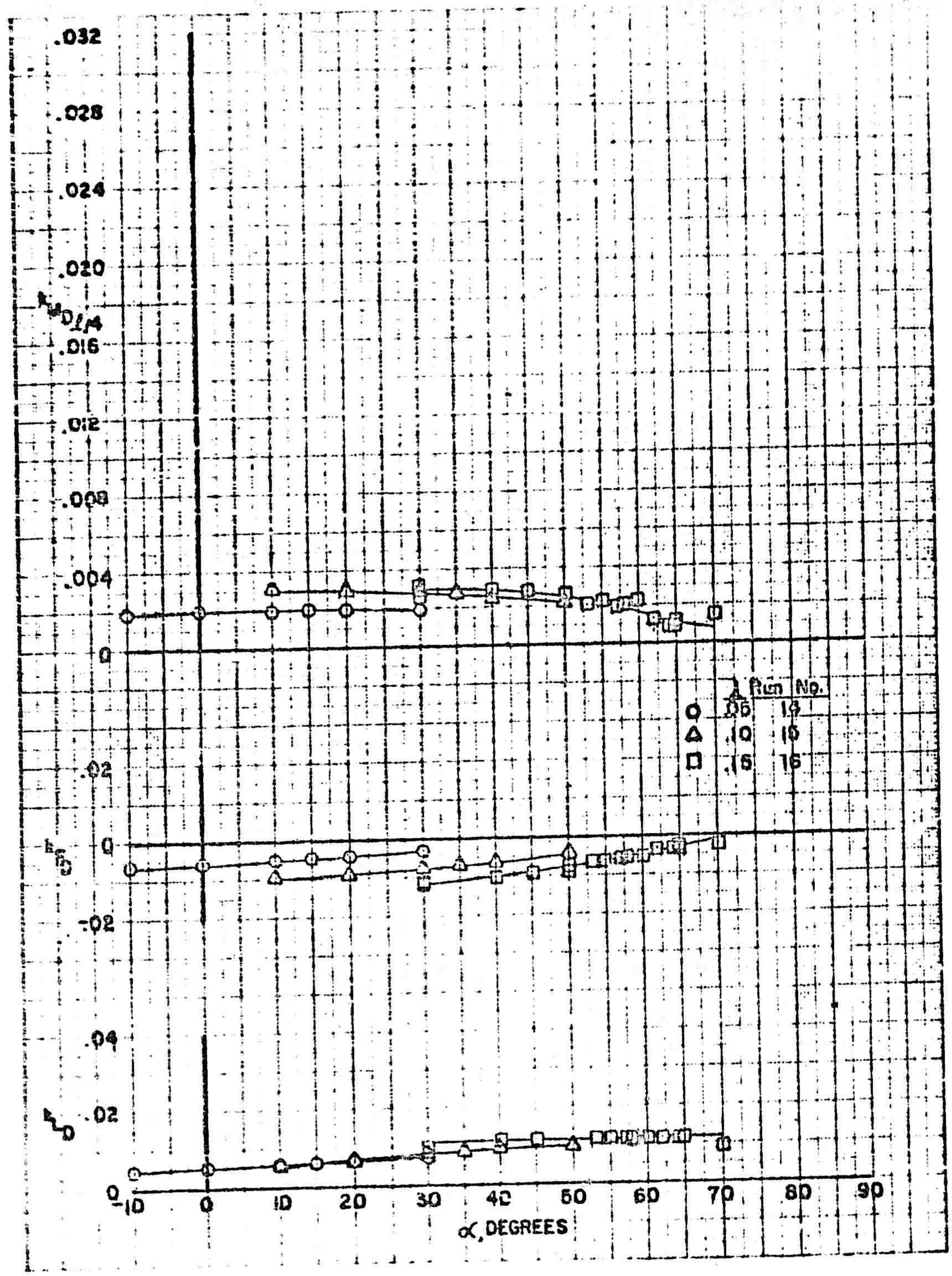

FIGURE 184 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1P_3S

$\beta = 15°$

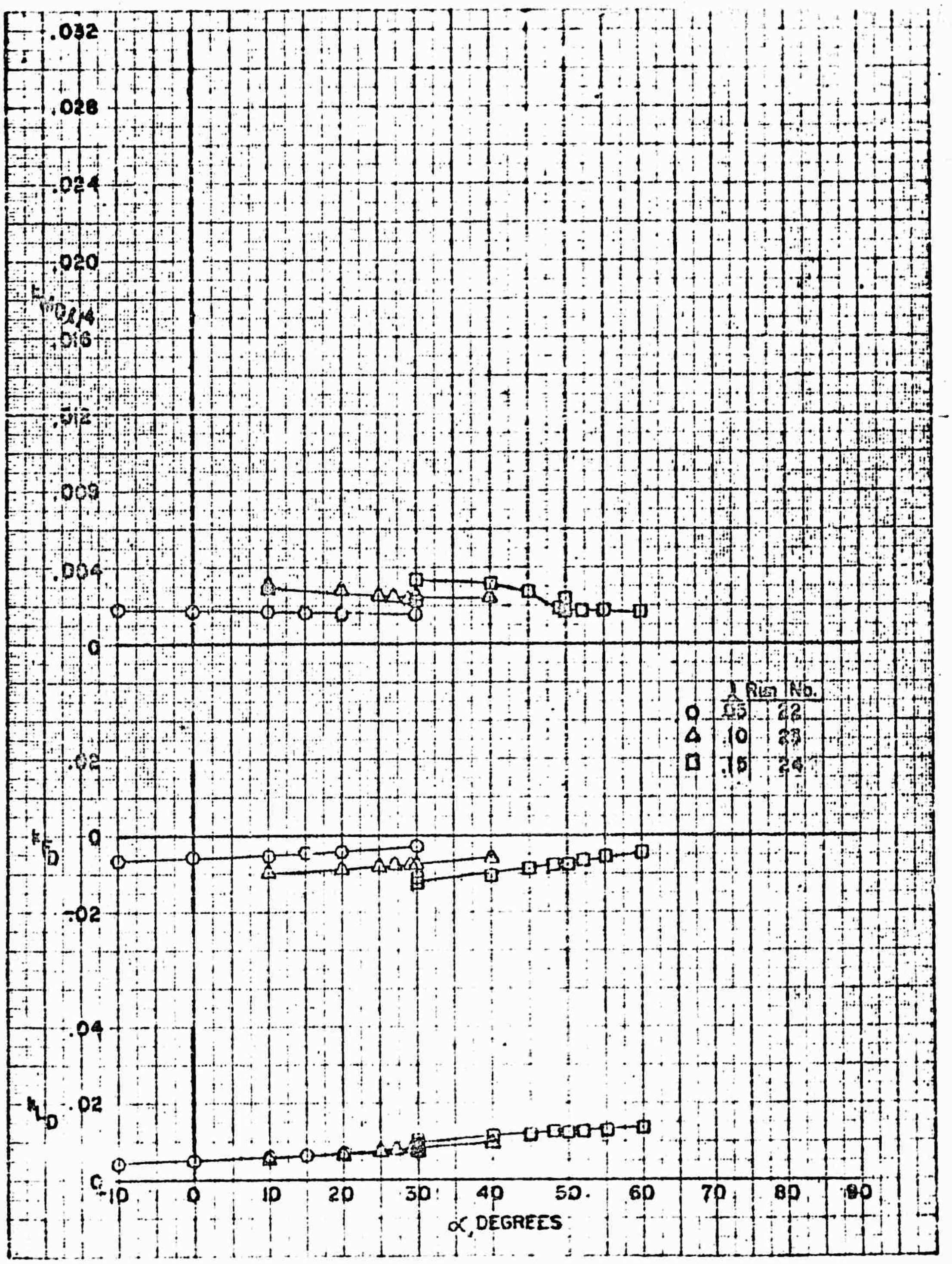

FIGURE 185 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

Configuration D_1P_3S

$\beta = 18°$

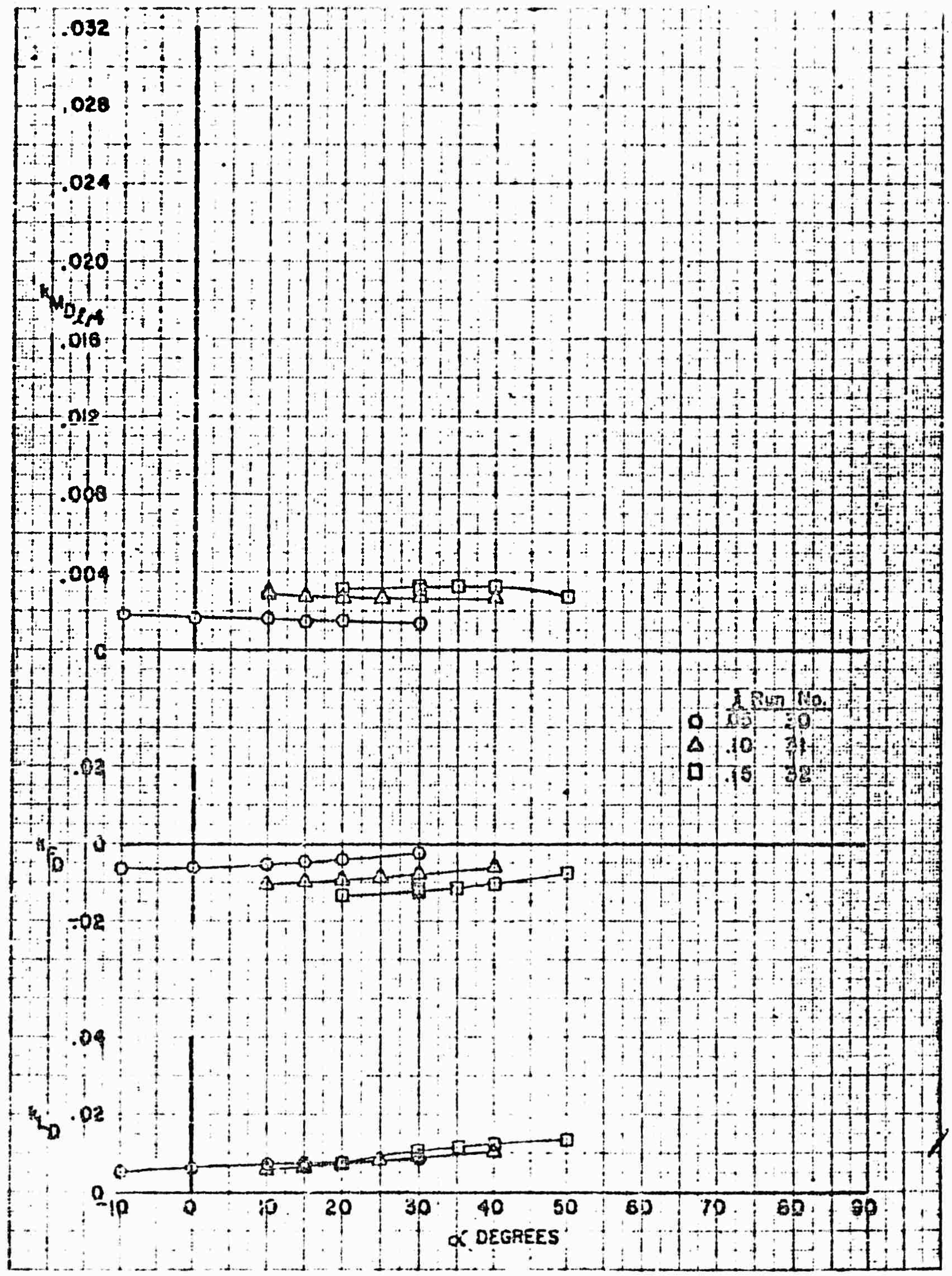

FIGURE 186 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_3S

$\beta = 9°$

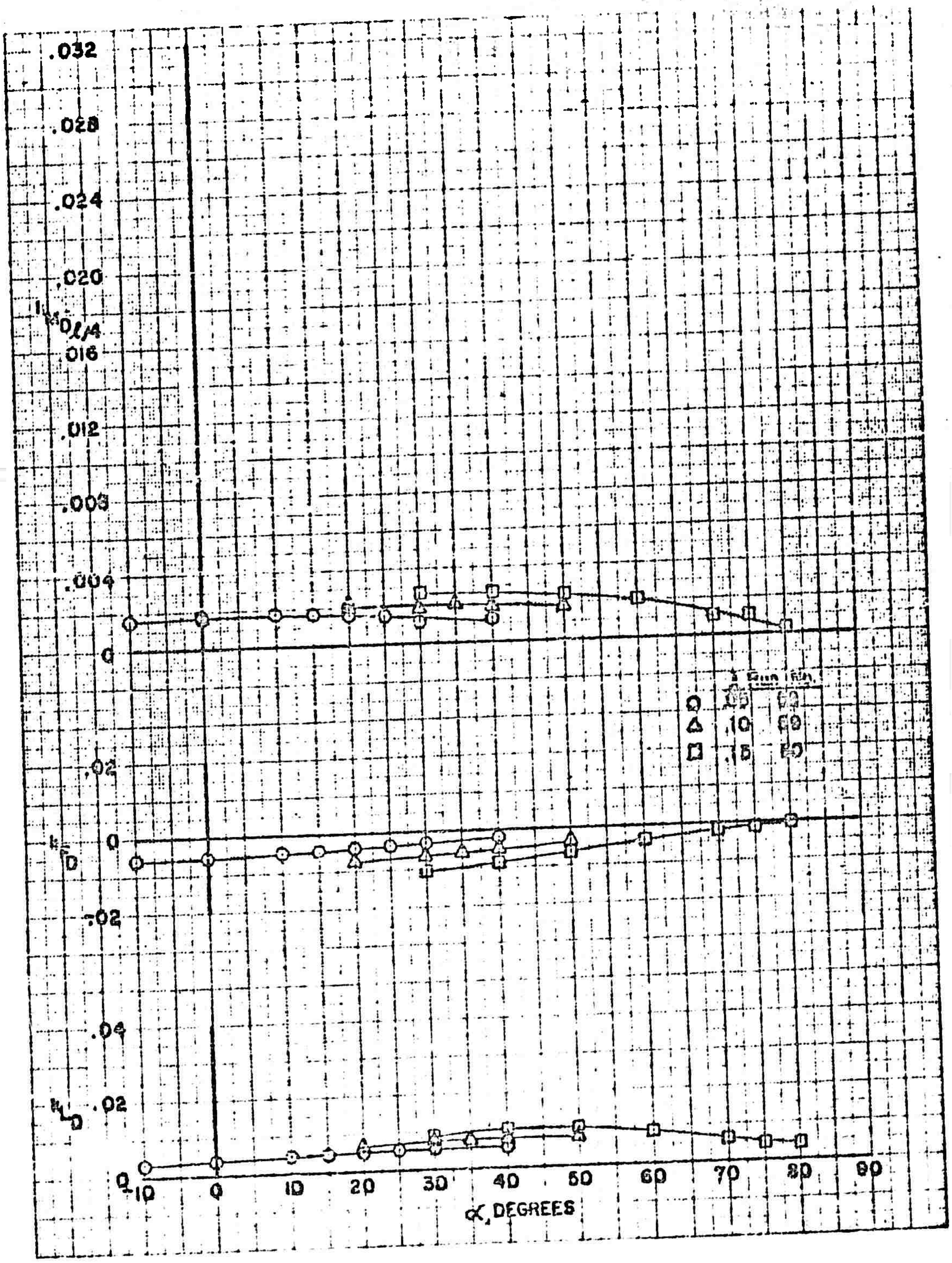

FIGURE 187 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase III

Configuration D_2P_3S

$\beta = 12^\circ$

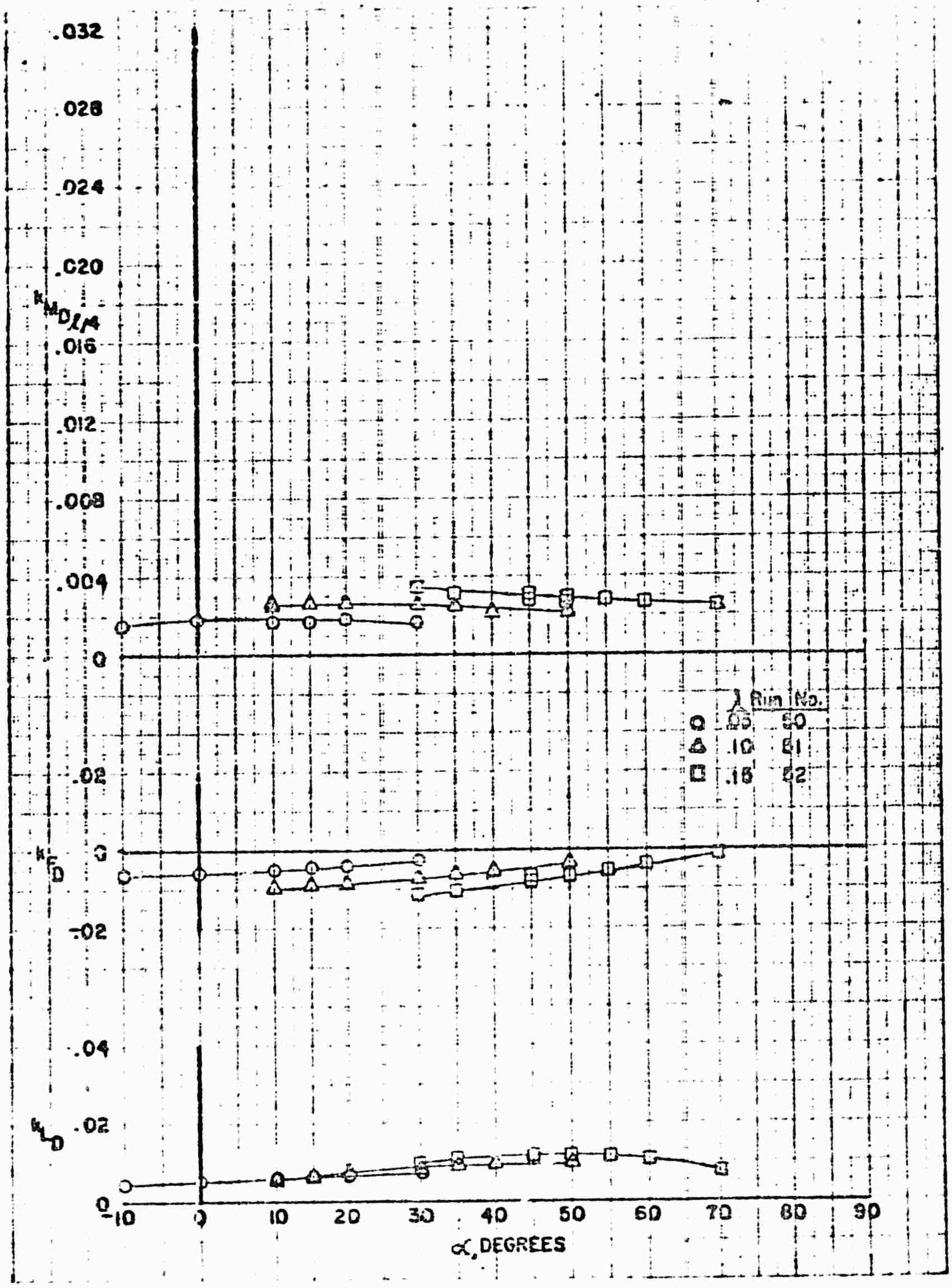

FIGURE 188 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_3S
$\beta = 15°$

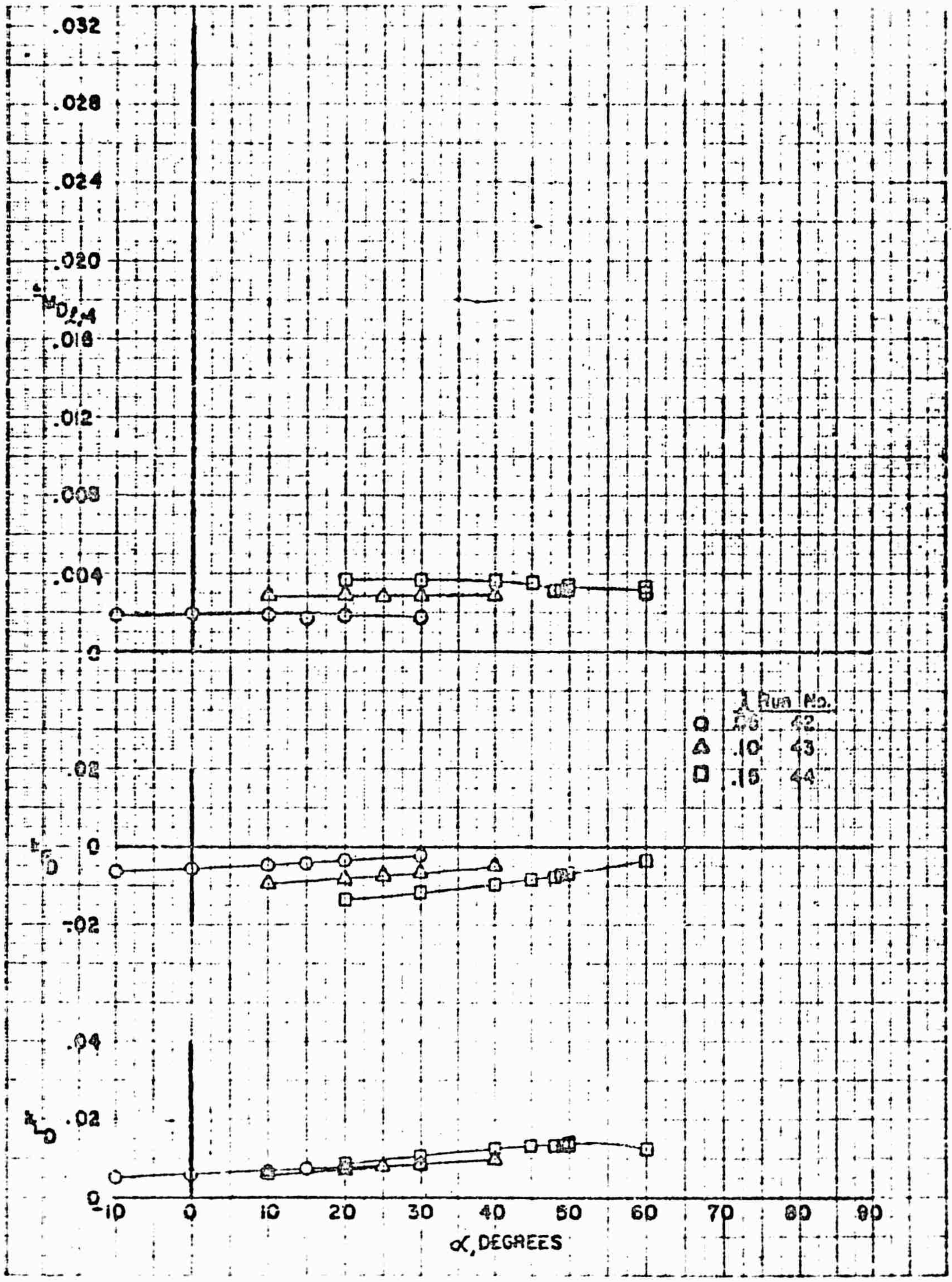

FIGURE 189 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

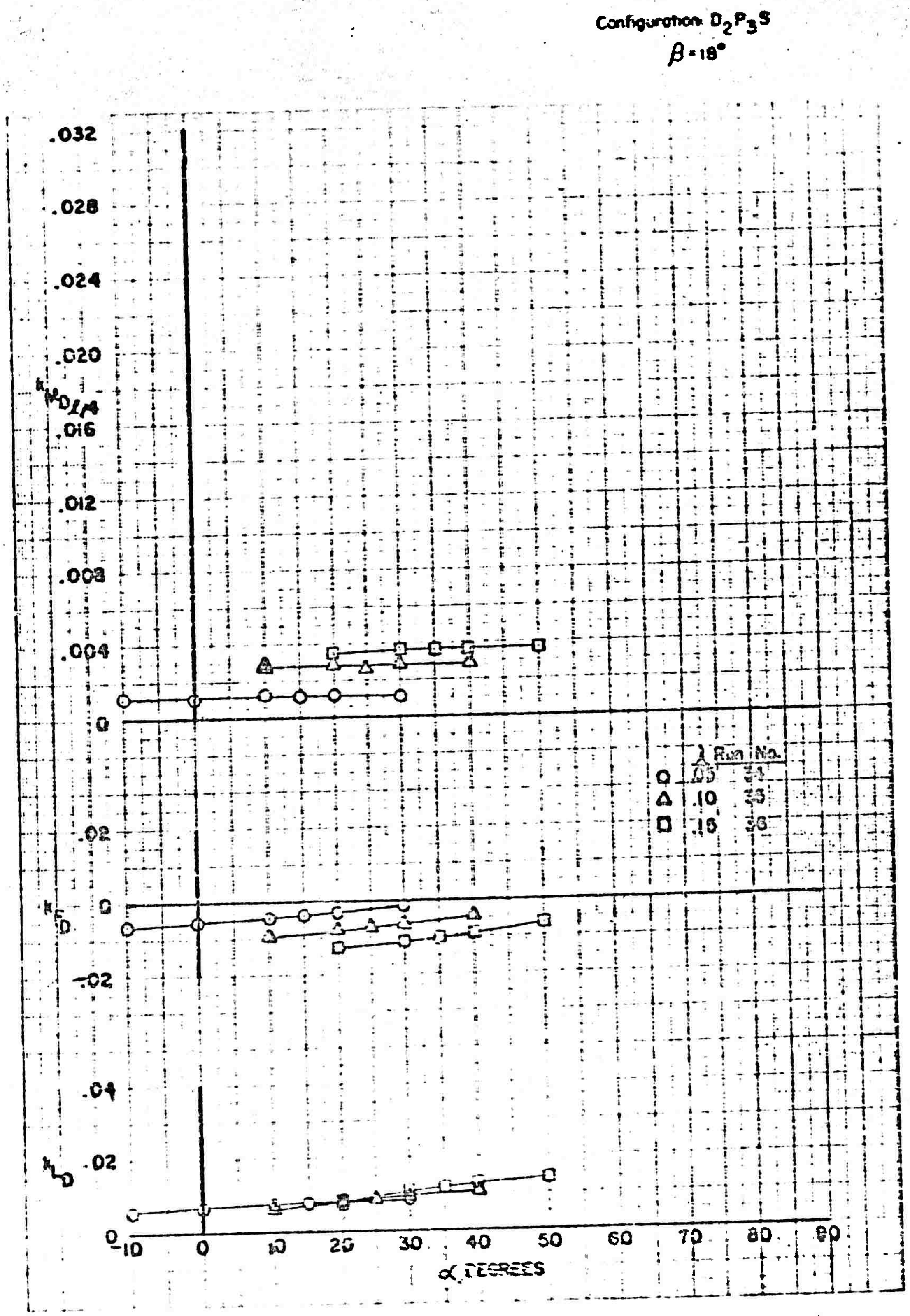

FIGURE 190 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S

$\beta = 9°$

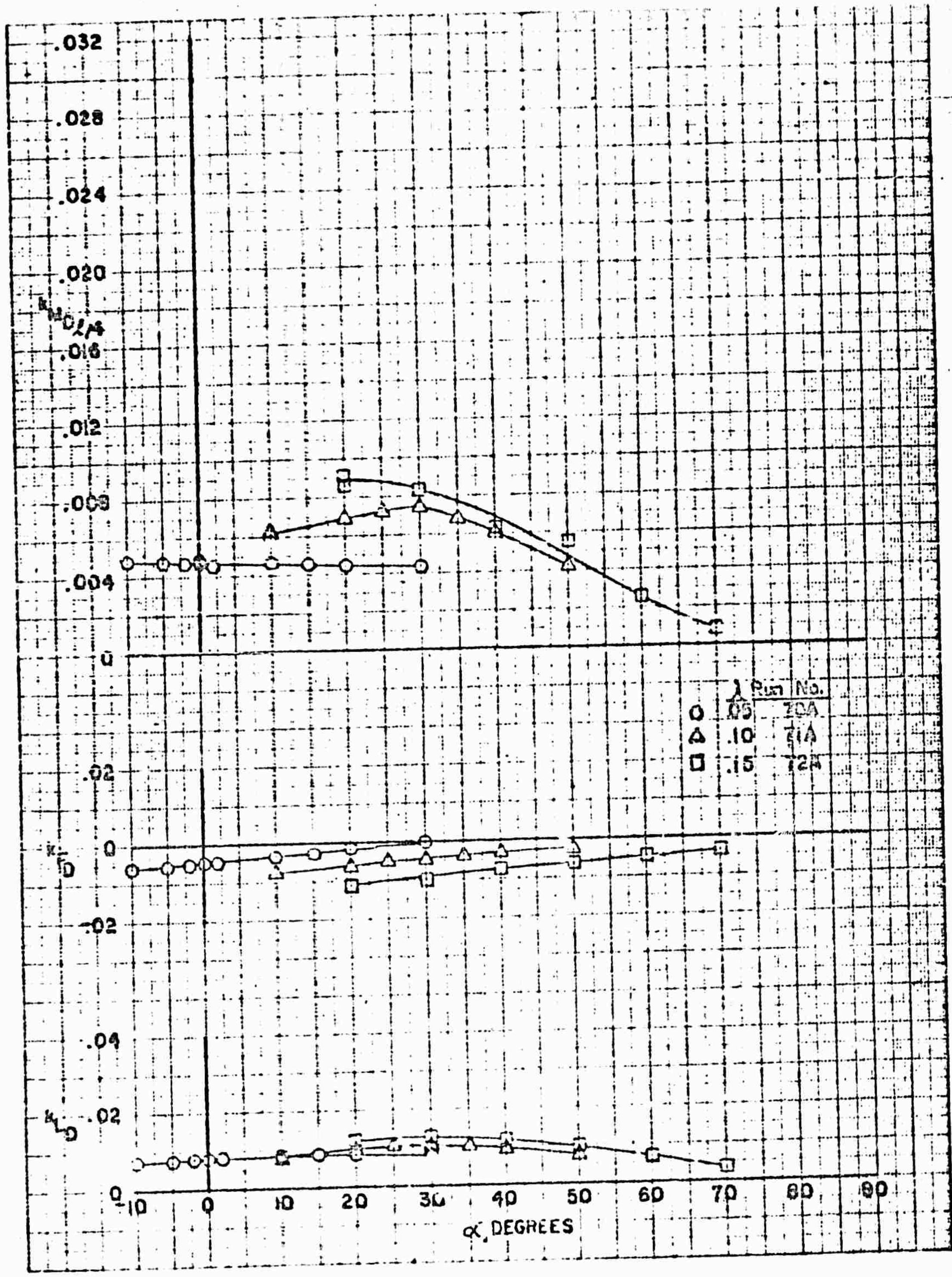

FIGURE 191 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

Configuration D_3P_3S
$\beta = 12°$

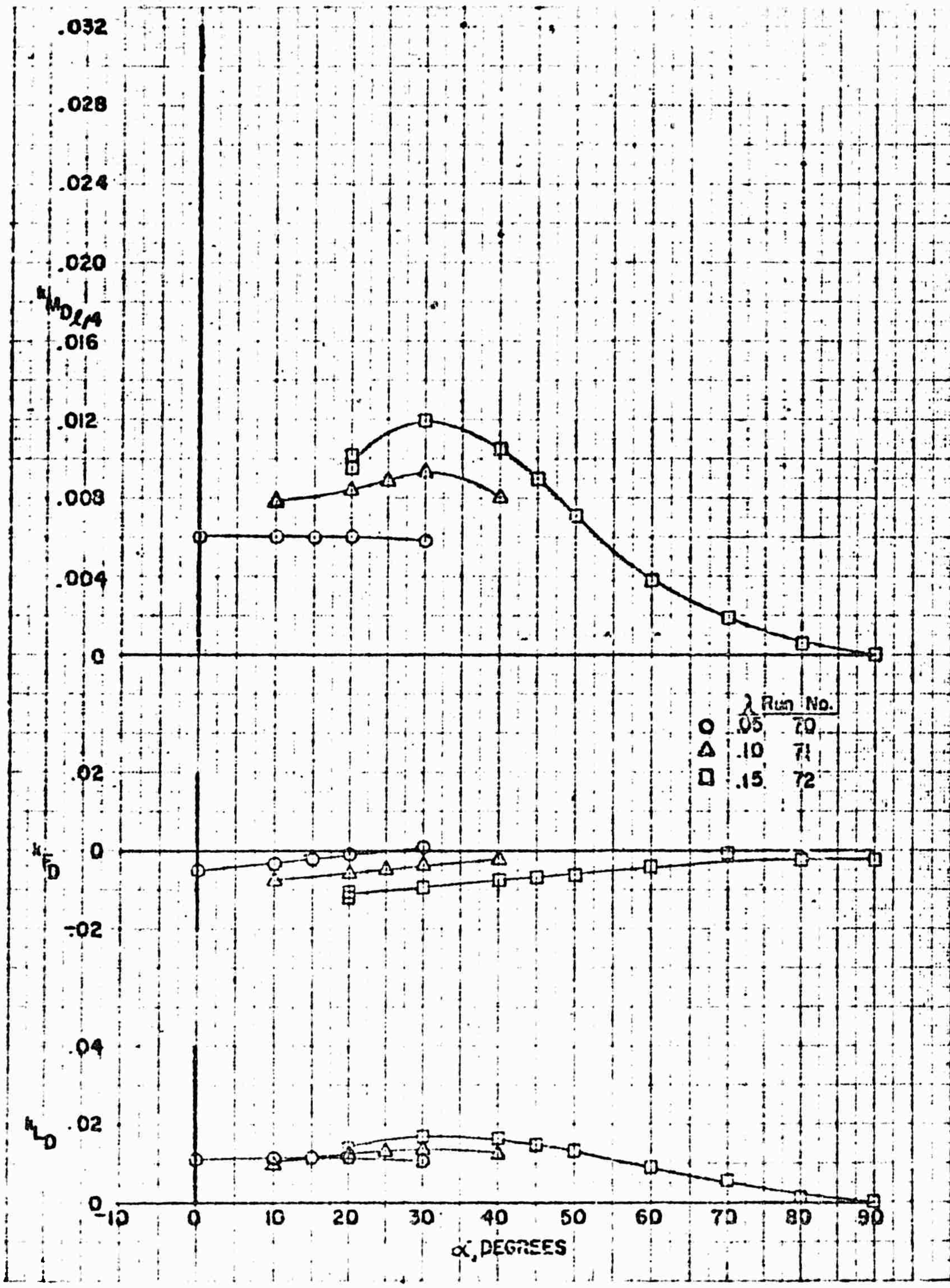

FIGURE 192 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S
$\beta = 15°$

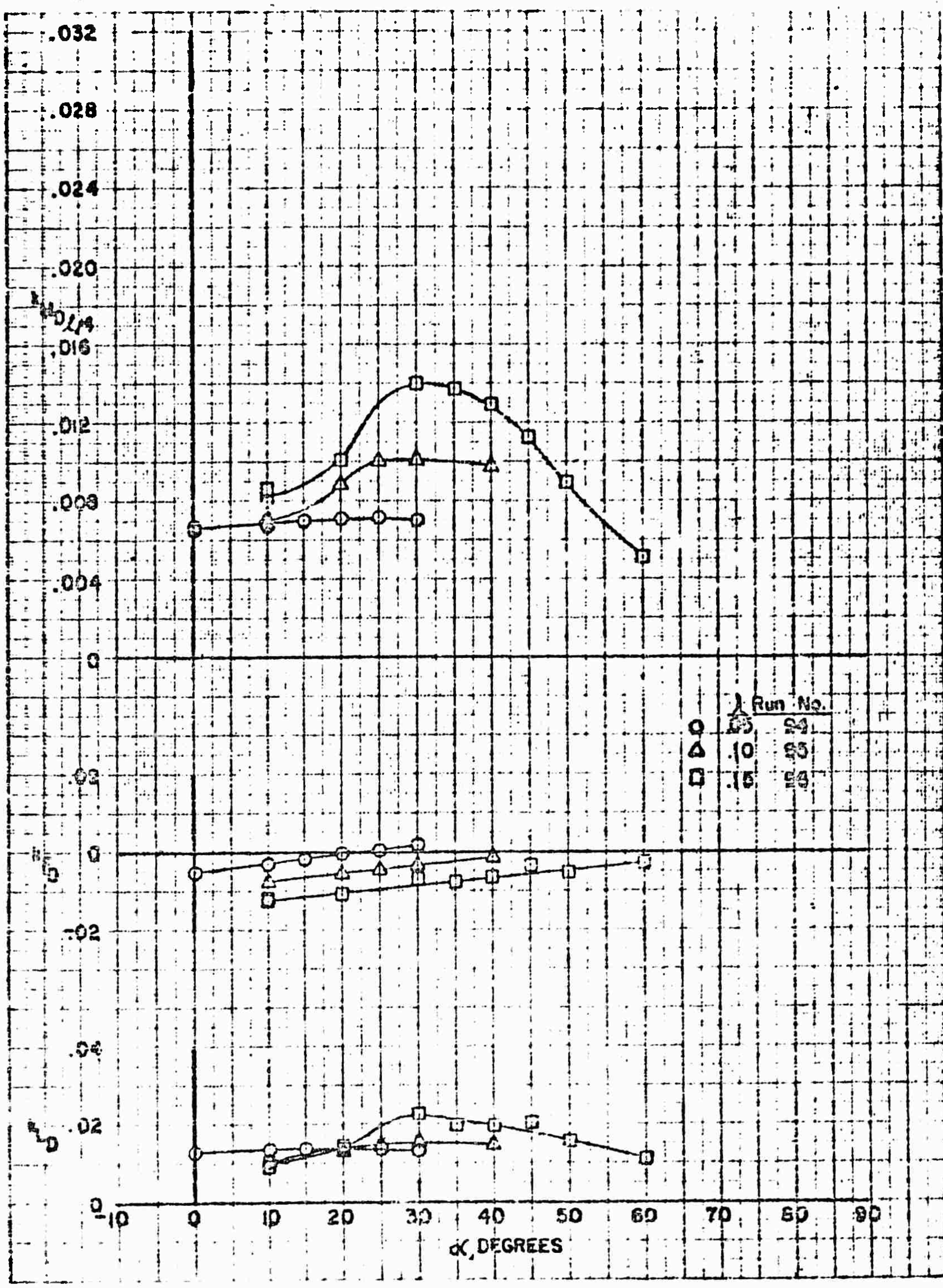

FIGURE 193 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

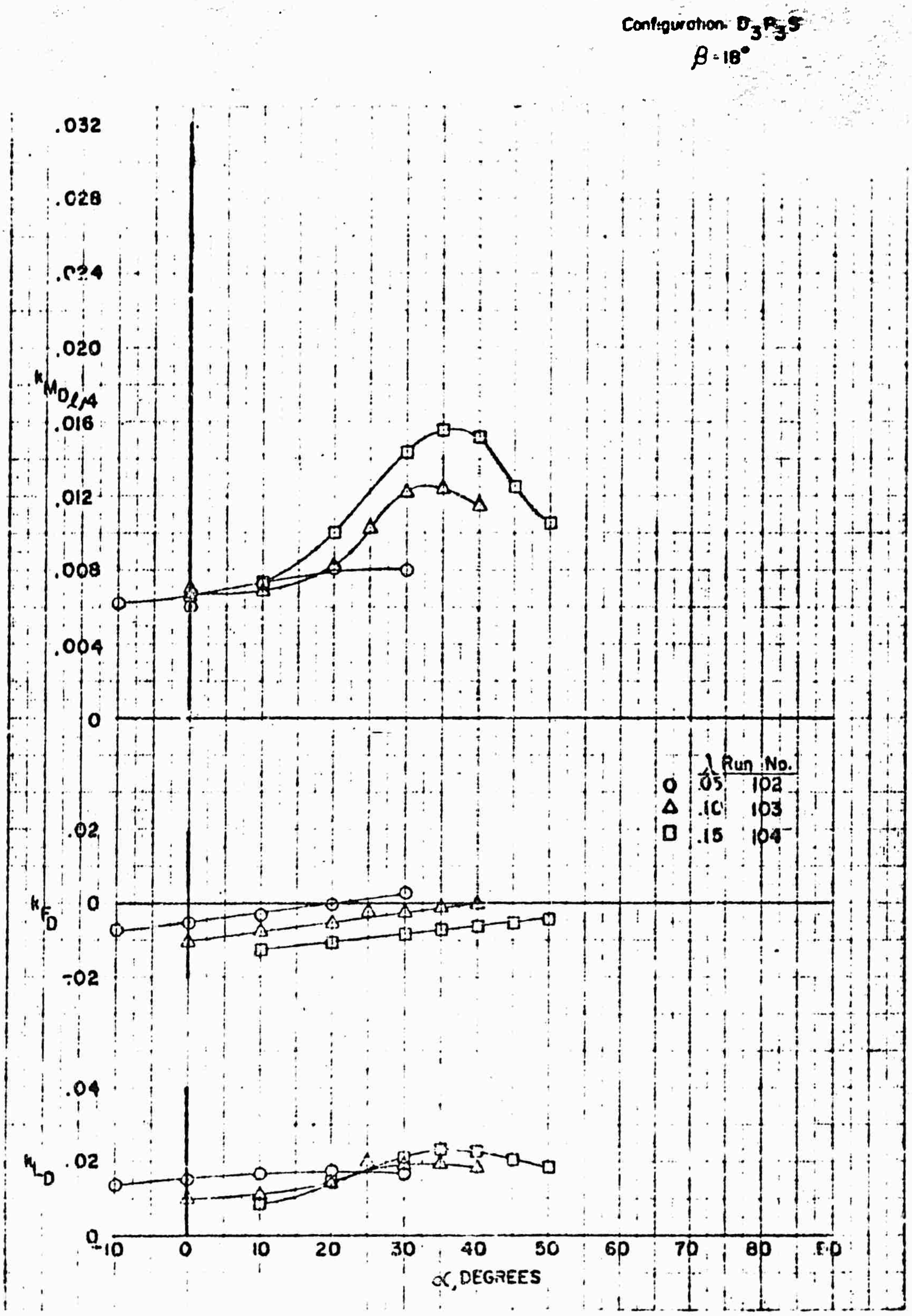

FIGURE 194 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S

$\beta = 21°$

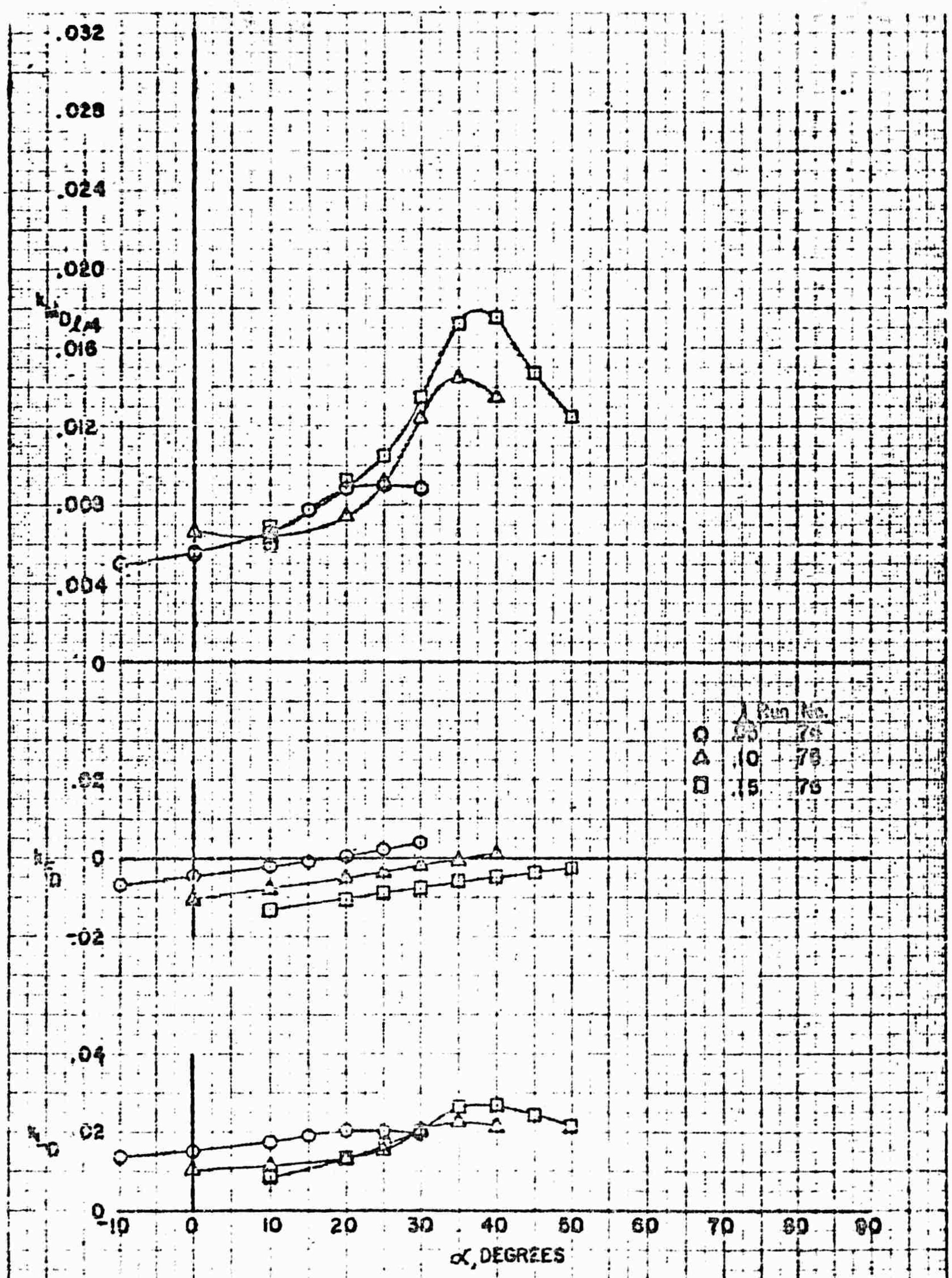

FIGURE 195 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S

$\beta = 24°$

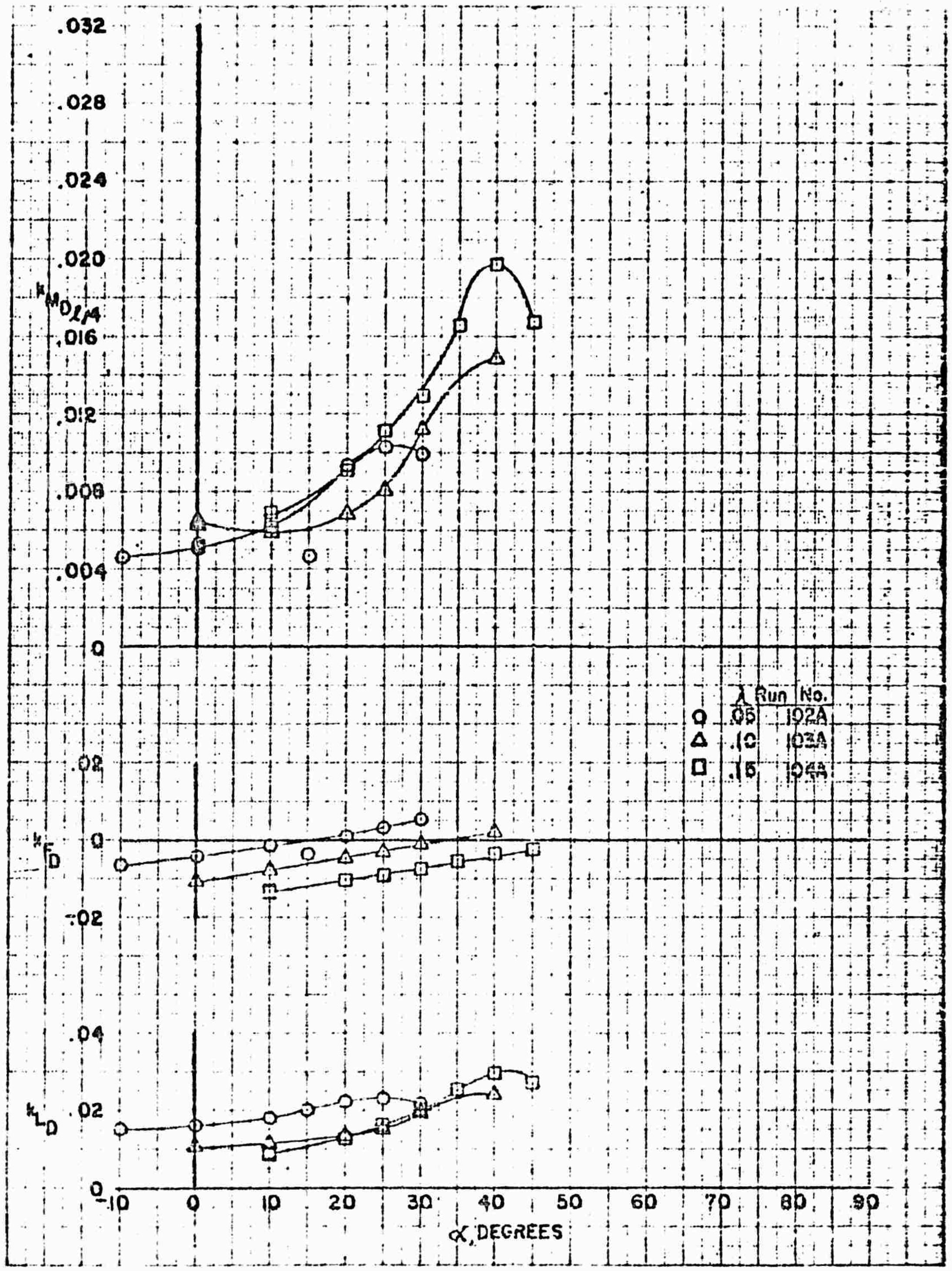

FIGURE 196 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_4P_3S

$\beta = 9°$

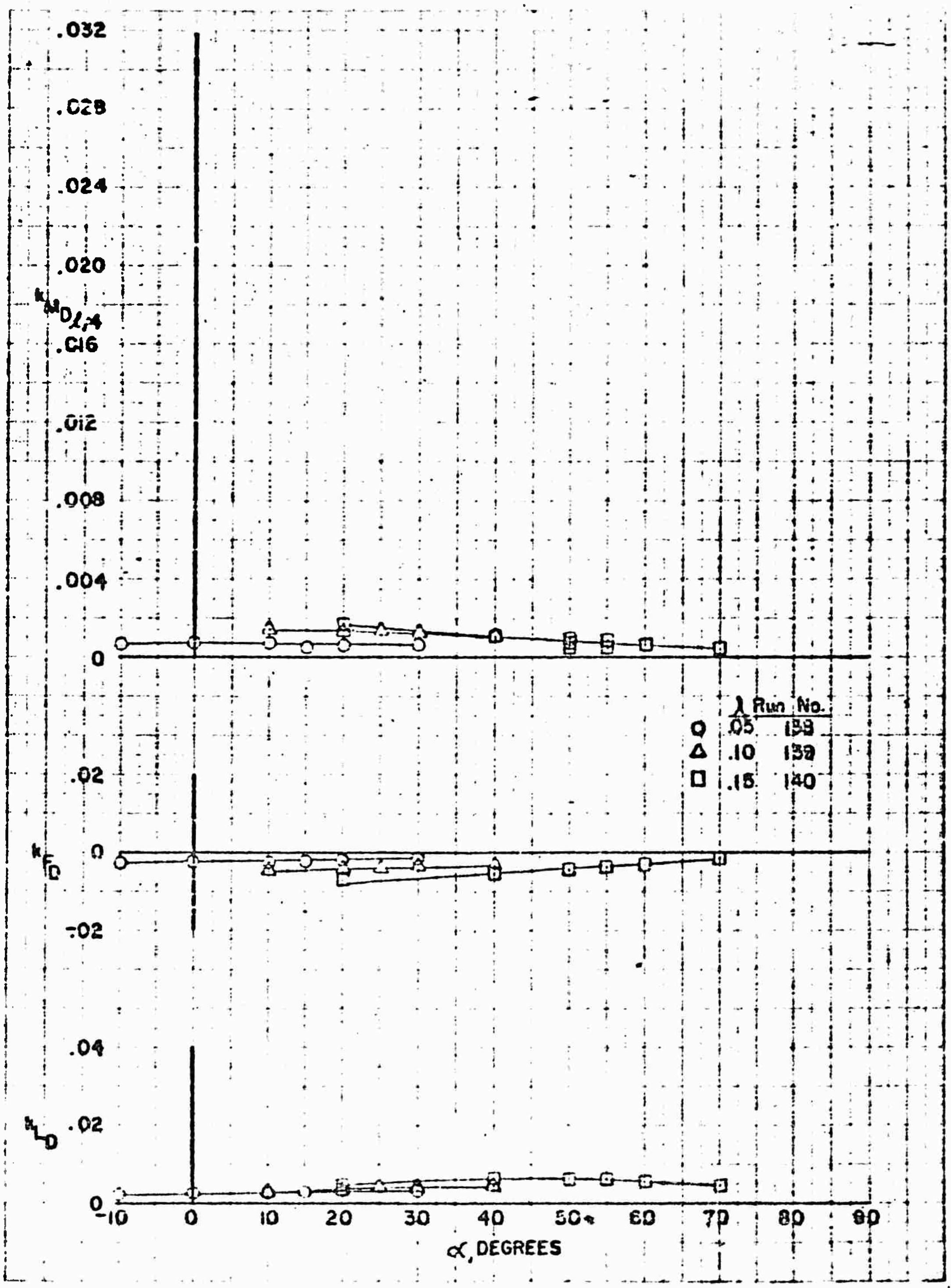

FIGURE 197 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_4 P_3 S$

$\beta = 12°$

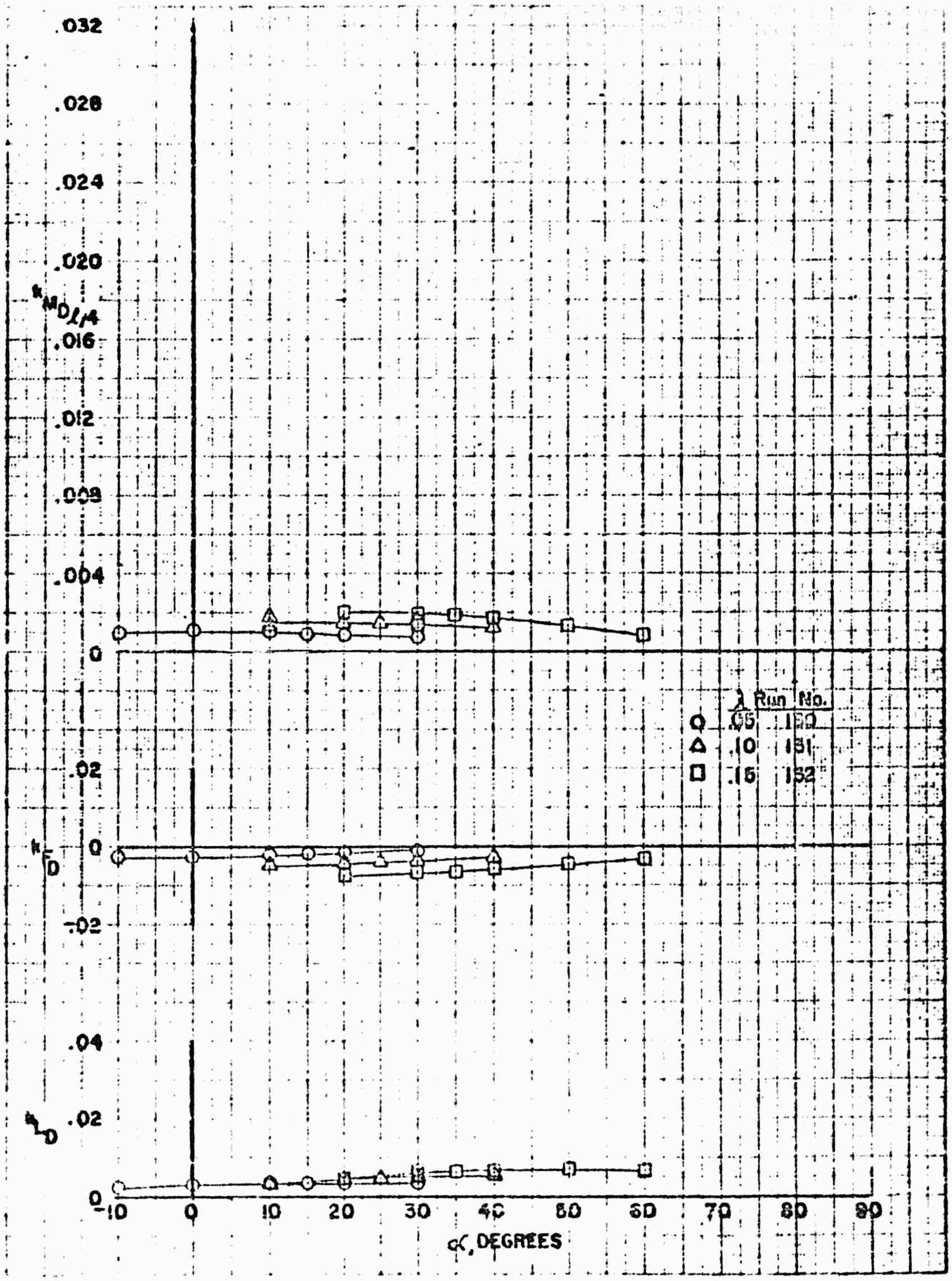

FIGURE 198 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

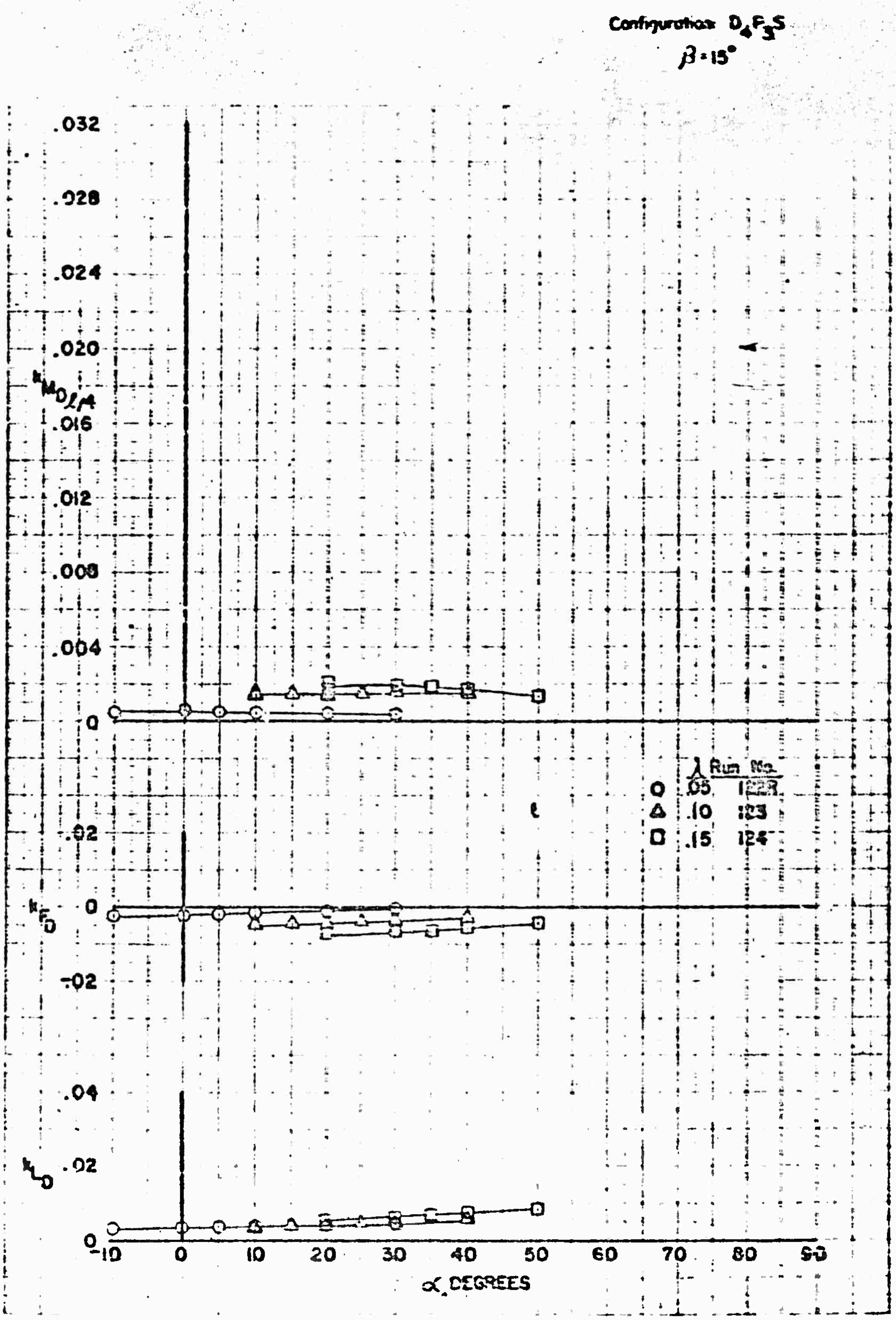

FIGURE 199 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_4 P_3 S$

$\beta = 18°$

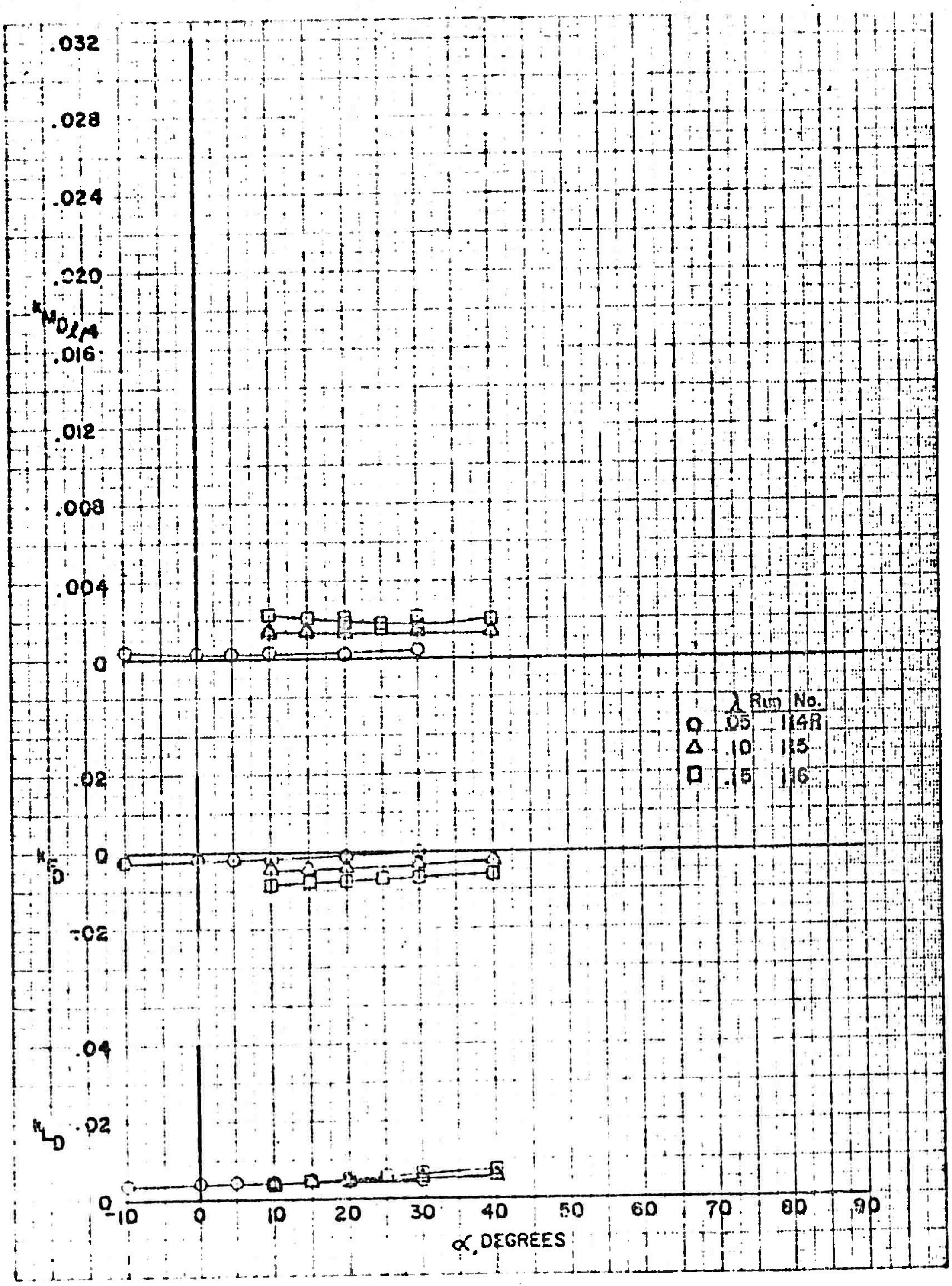

FIGURE 200 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (OO) Phase IV

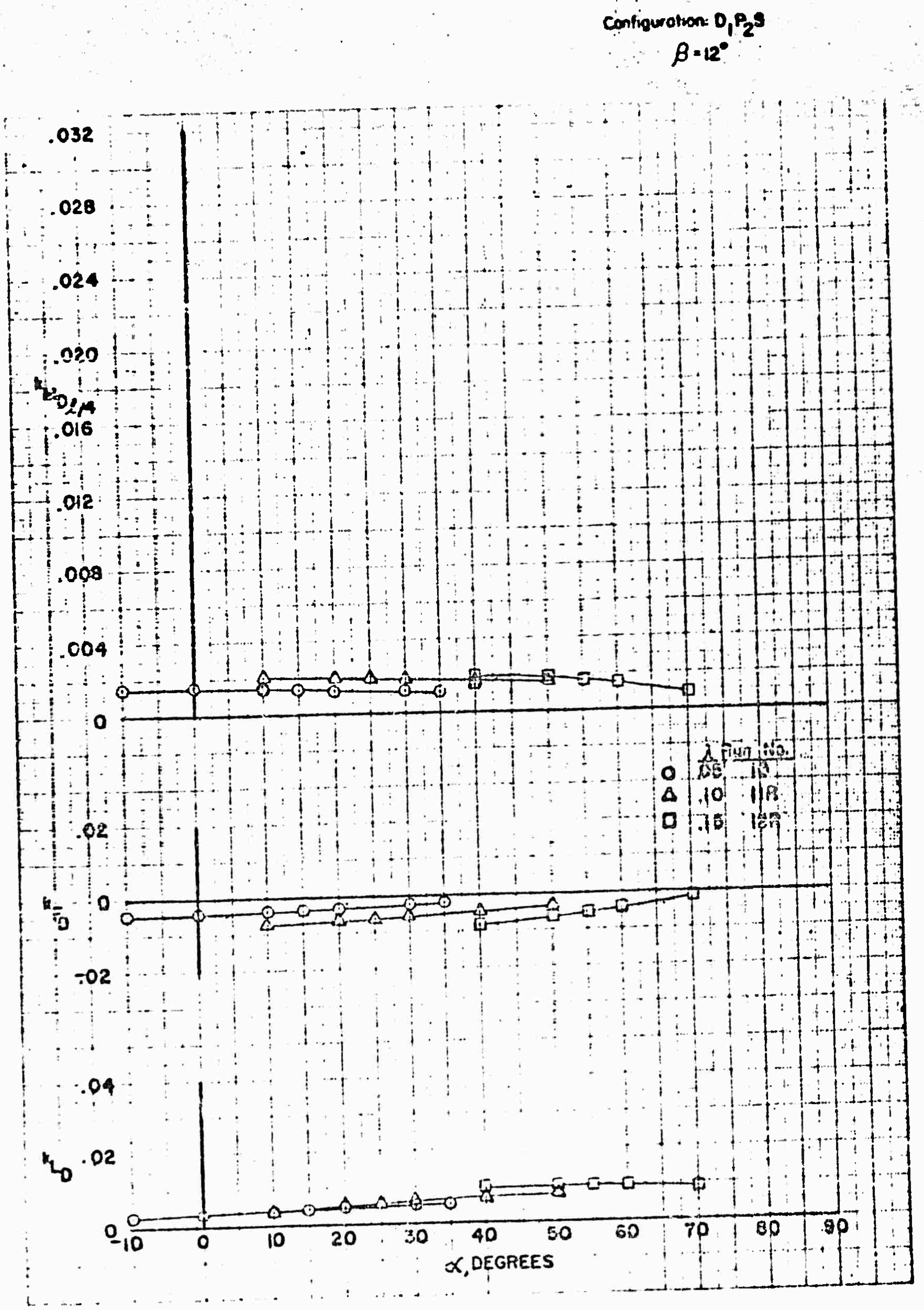

FIGURE 201 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_2P_2S

$\beta = 12°$

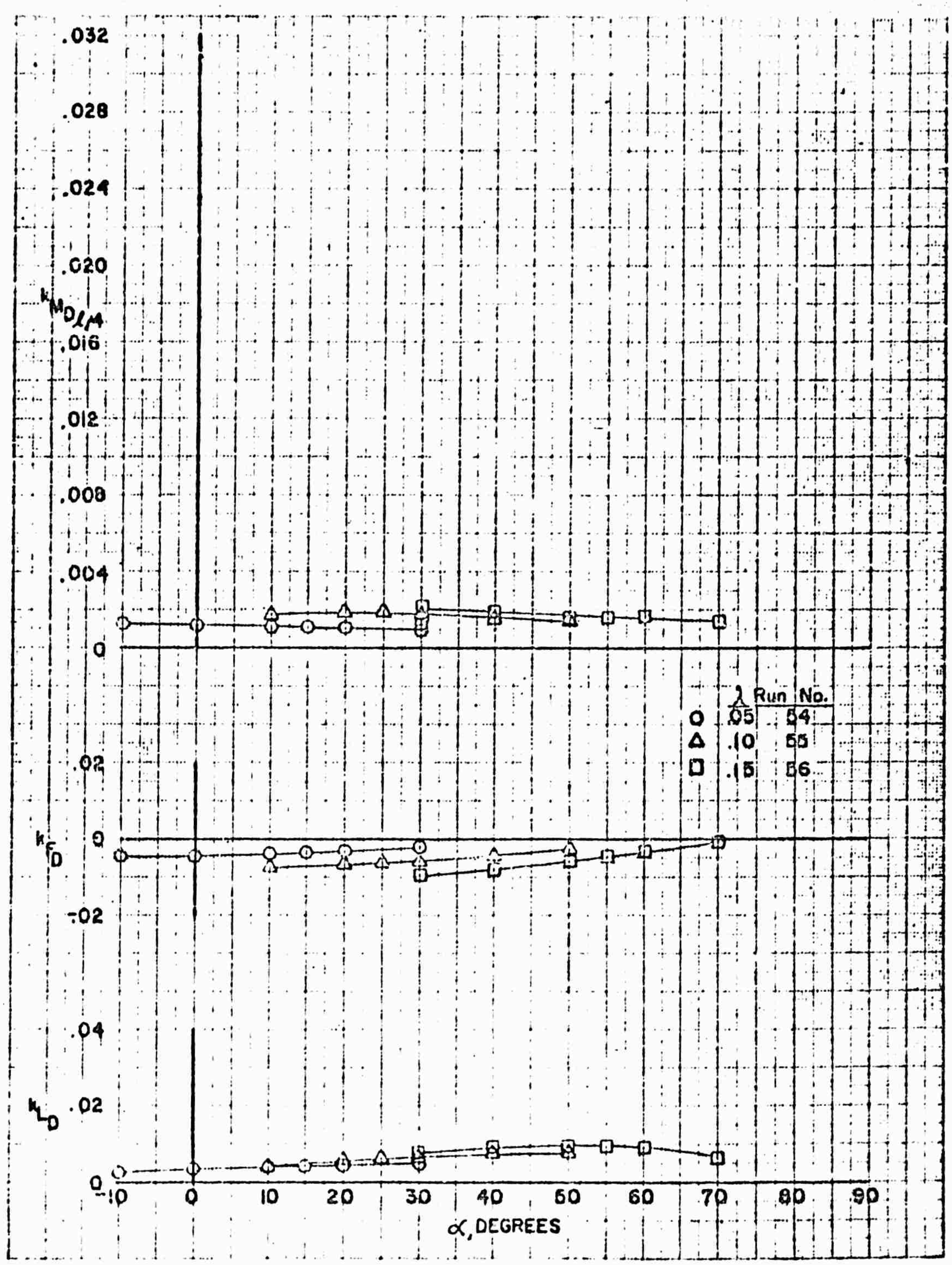

FIGURE 202 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S

$\beta = 9°$

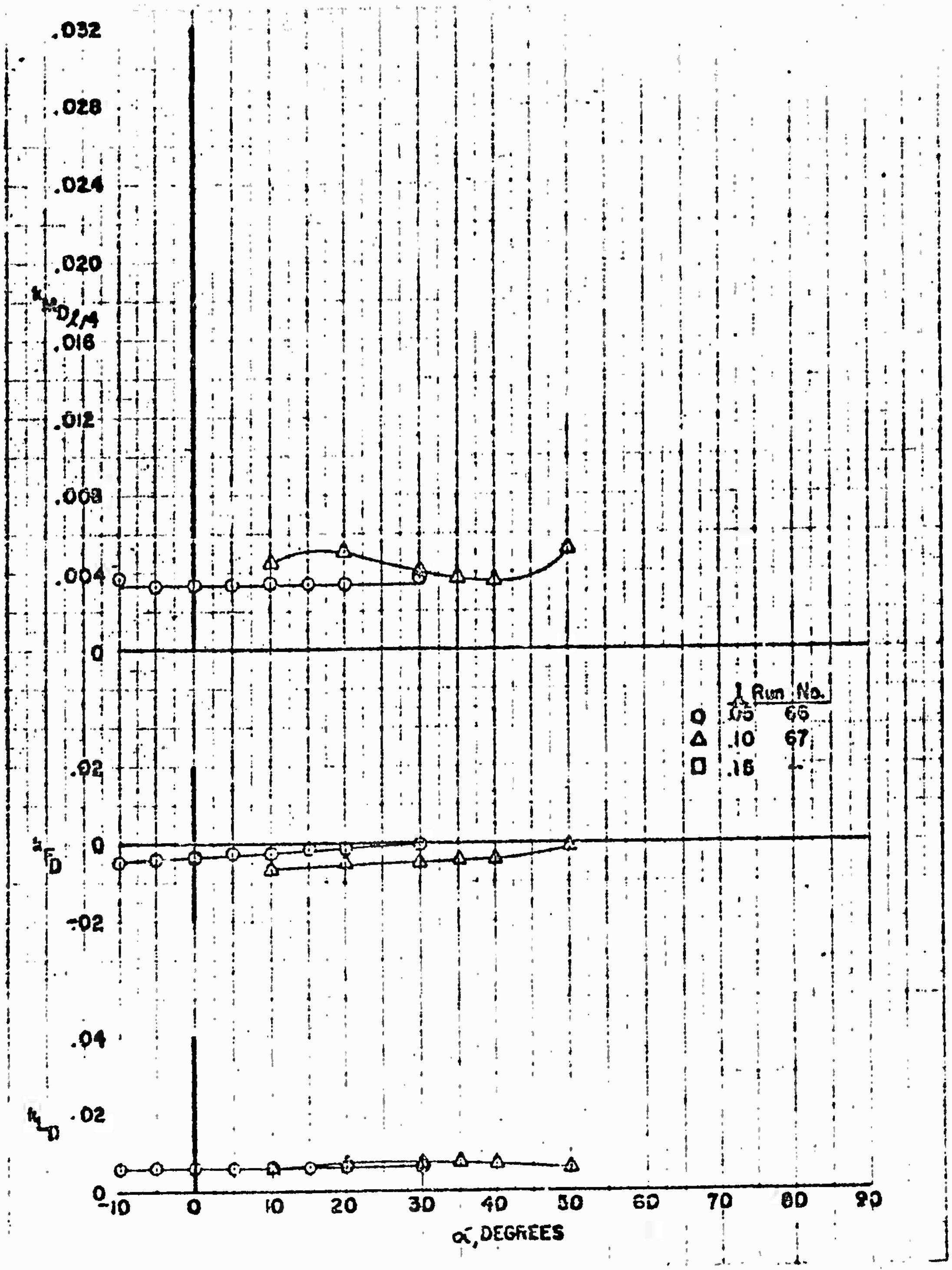

FIGURE 2C3 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S
$\xi = 12°$

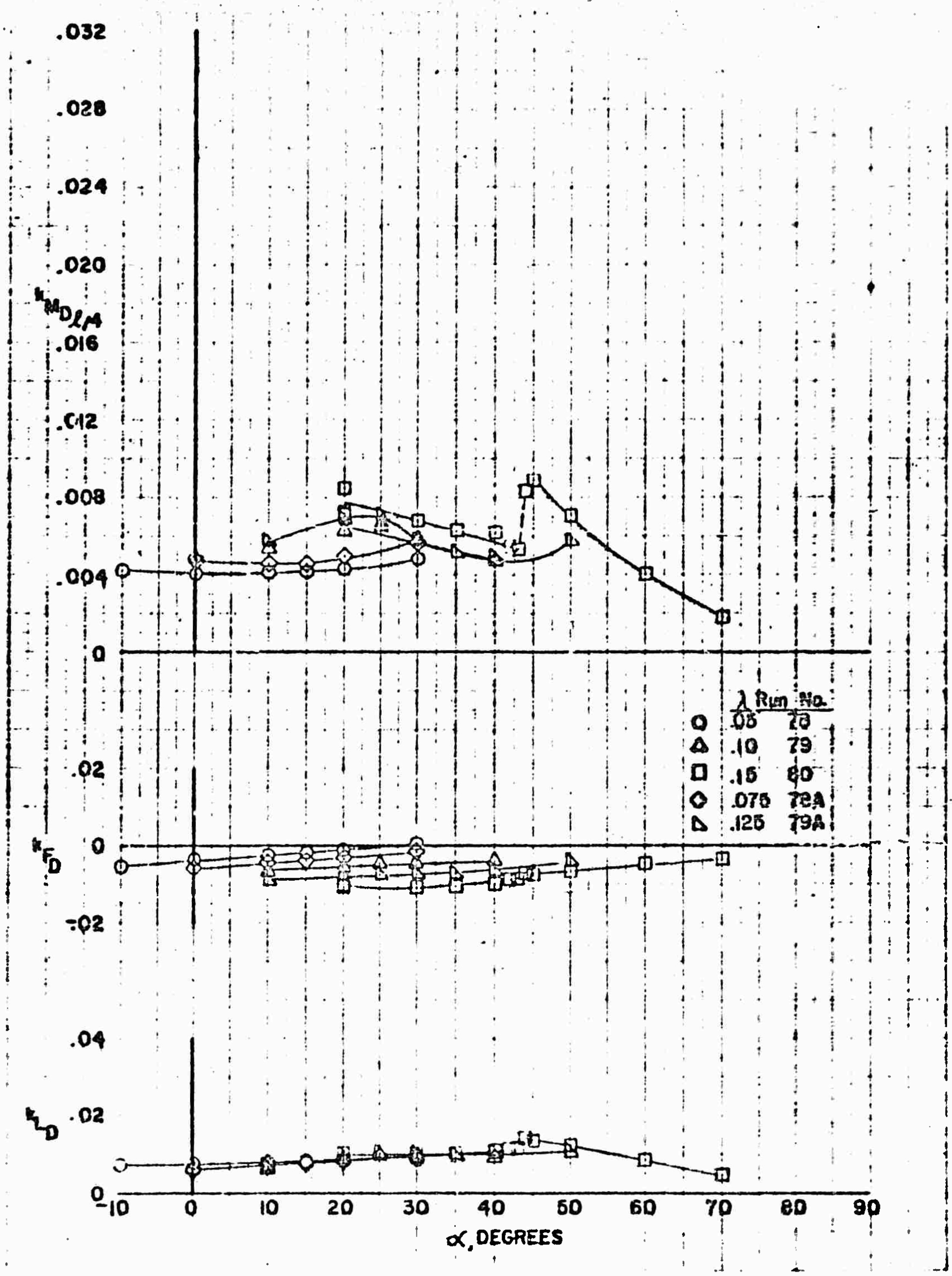

FIGURE 204 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_2S
$\beta = 18°$

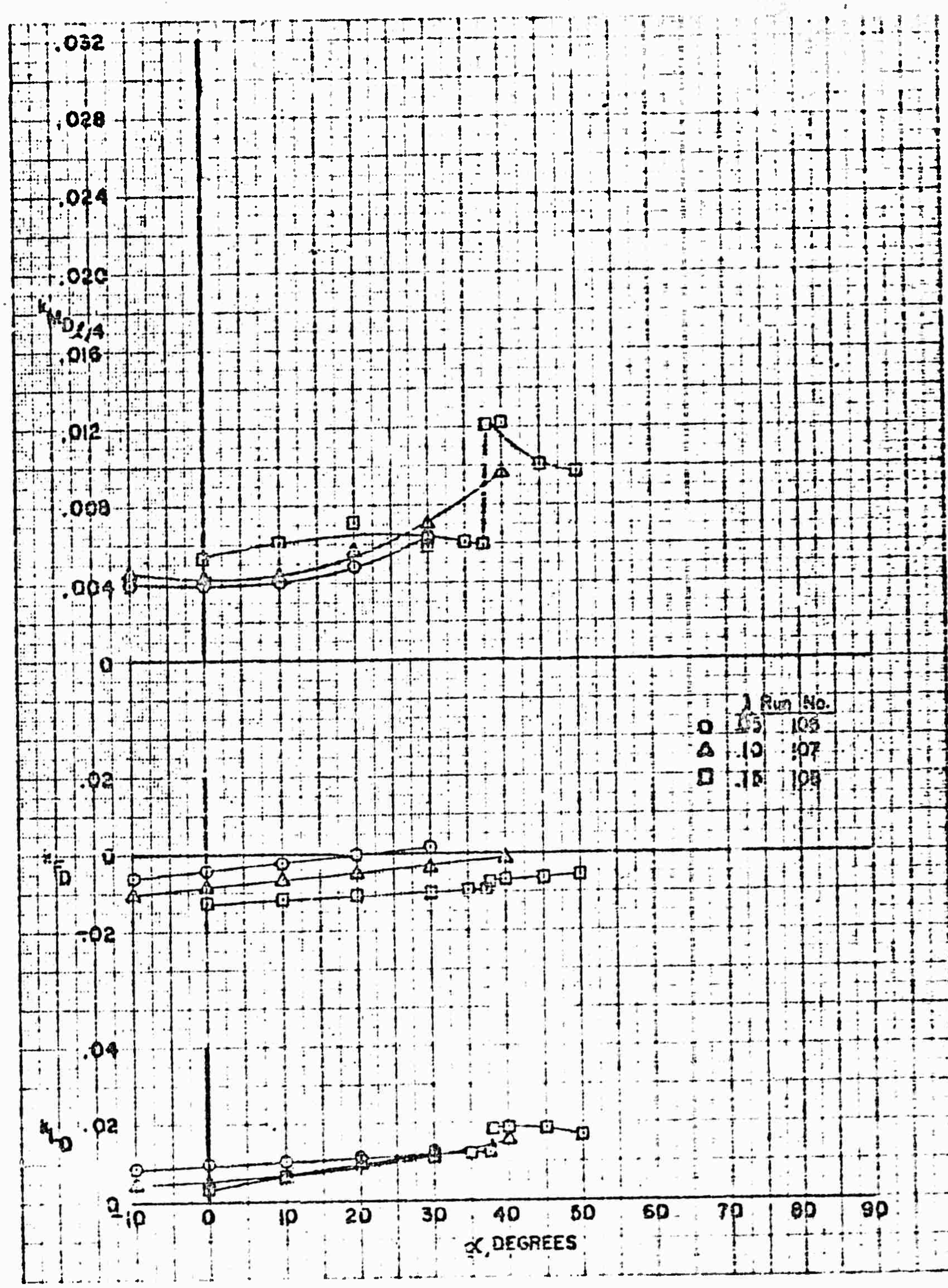

FIGURE 205 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_4P_2S
$\beta = 12°$

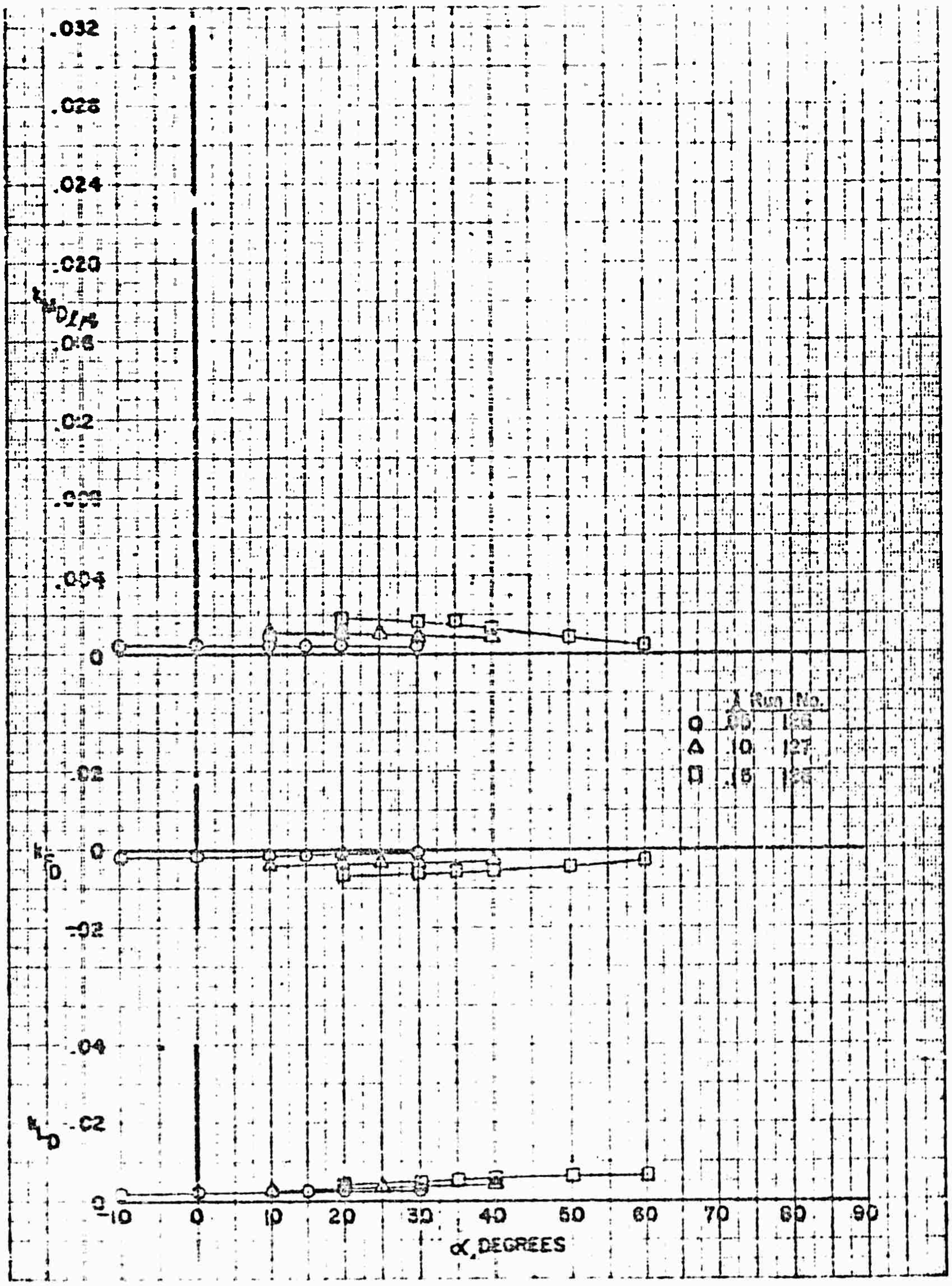

FIGURE 206 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_2P_pS

$\beta = 12°$

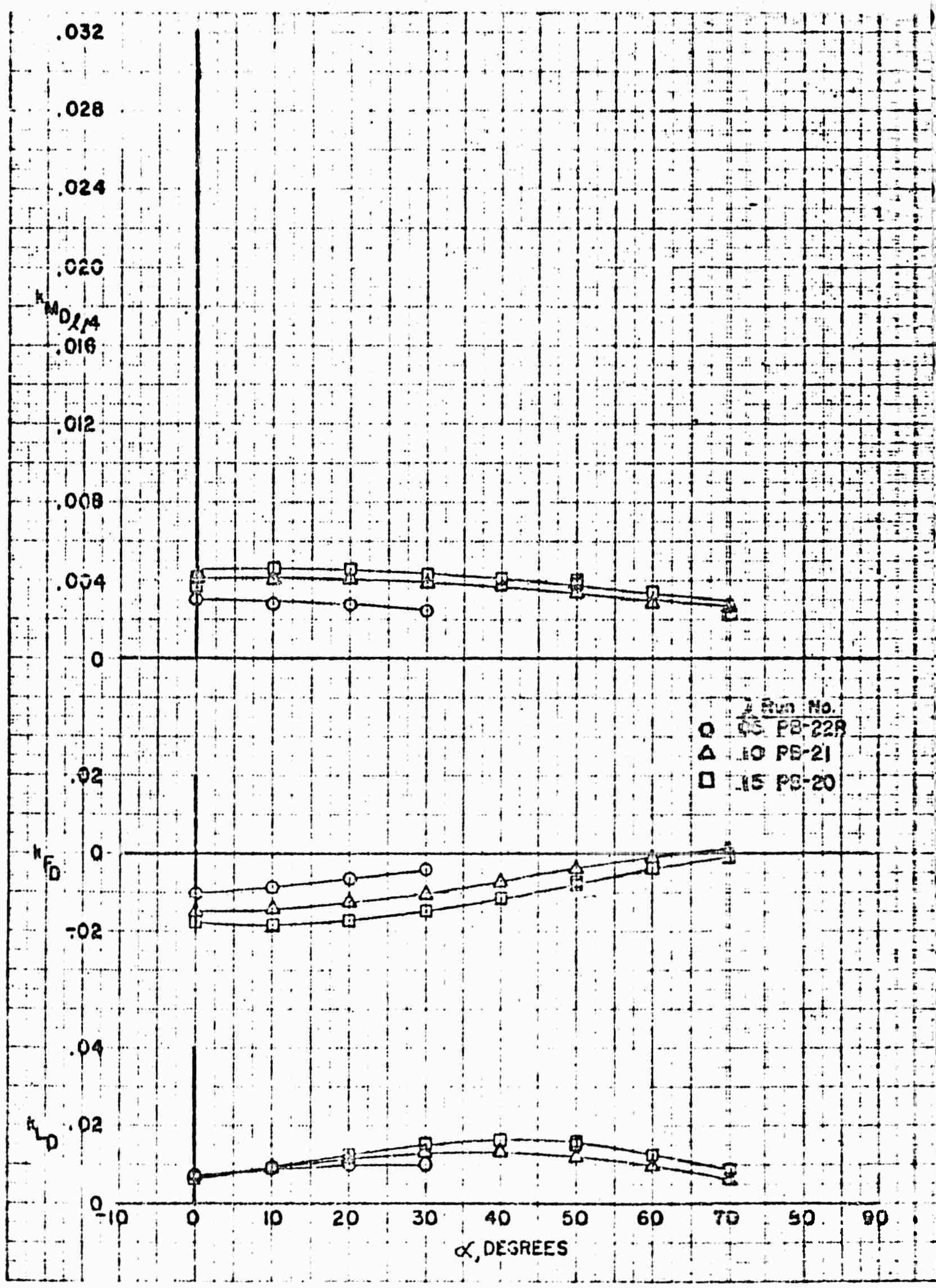

FIGURE 207 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_2 P_p S$

$\lambda = .15$

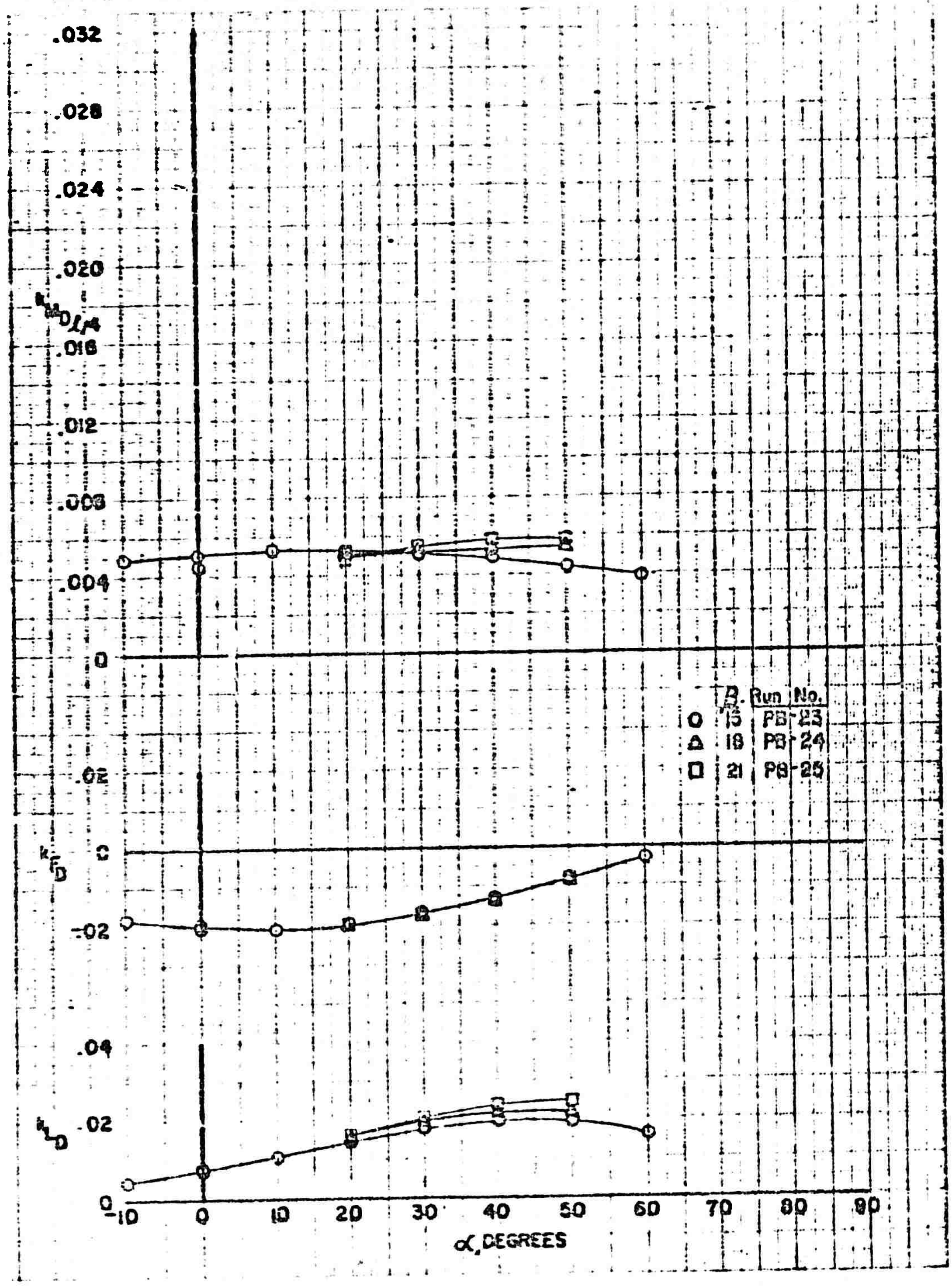

FIGURE 208 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1327(00) Phase IV

Configuration D_3P_pS

$\lambda = .15$

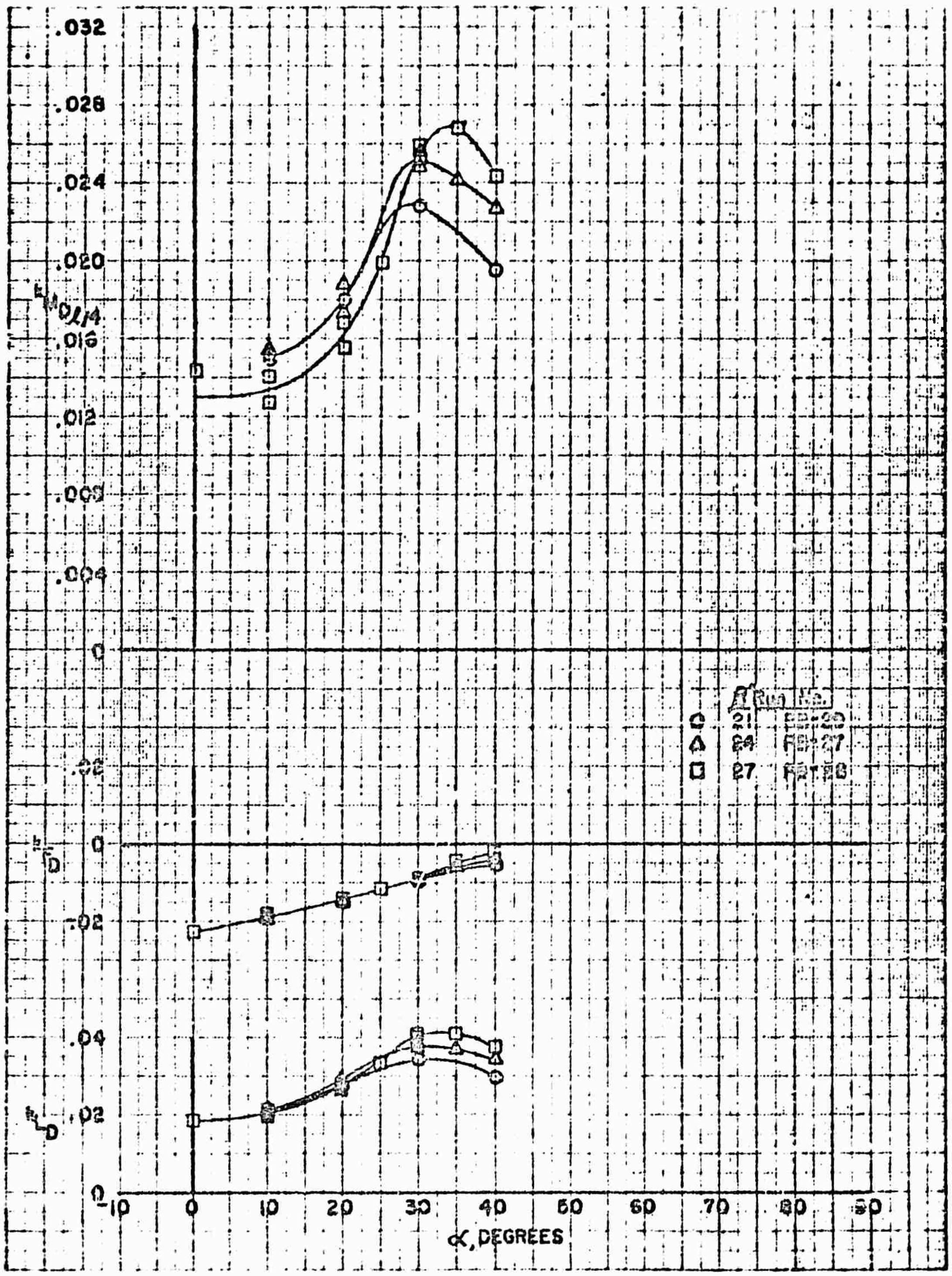

FIGURE 209 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3SV_{-10}$

$\beta = 12^\circ$

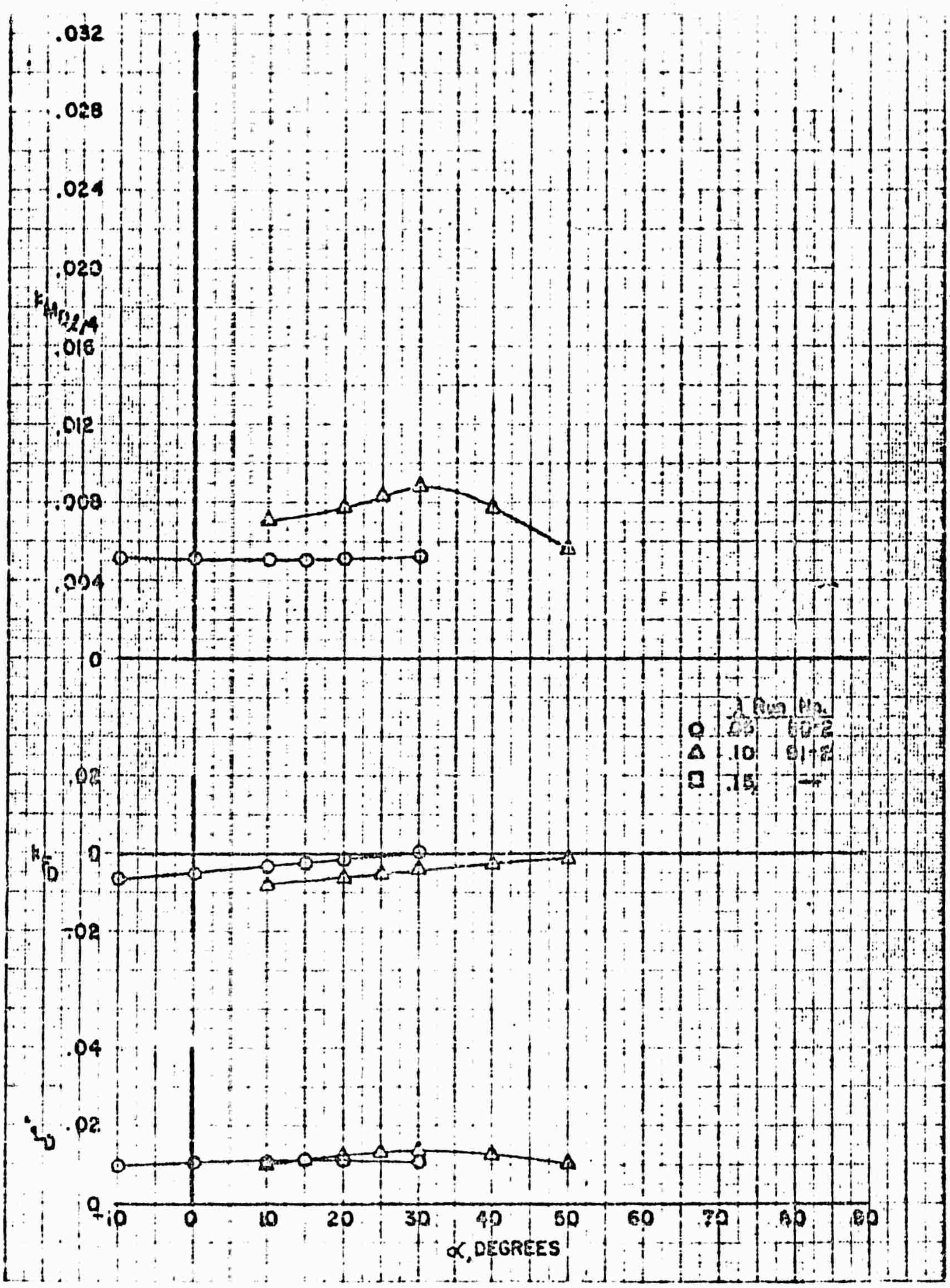

FIGURE 210 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P_3SV_{-5}$

$\beta = 12°$

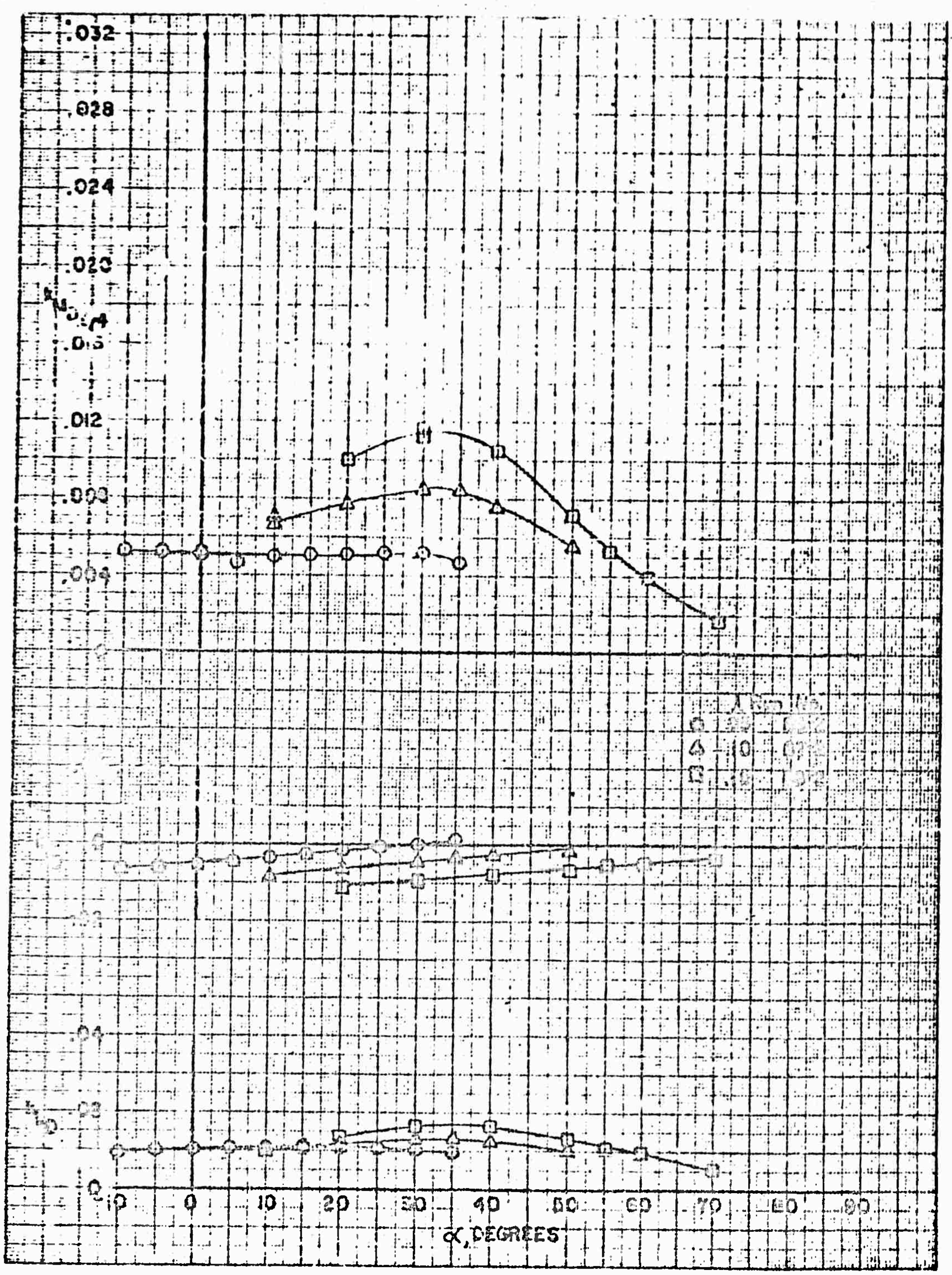

FIGURE 211 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

Configuration: $D_3P_3SV_0$

$\beta = 12°$

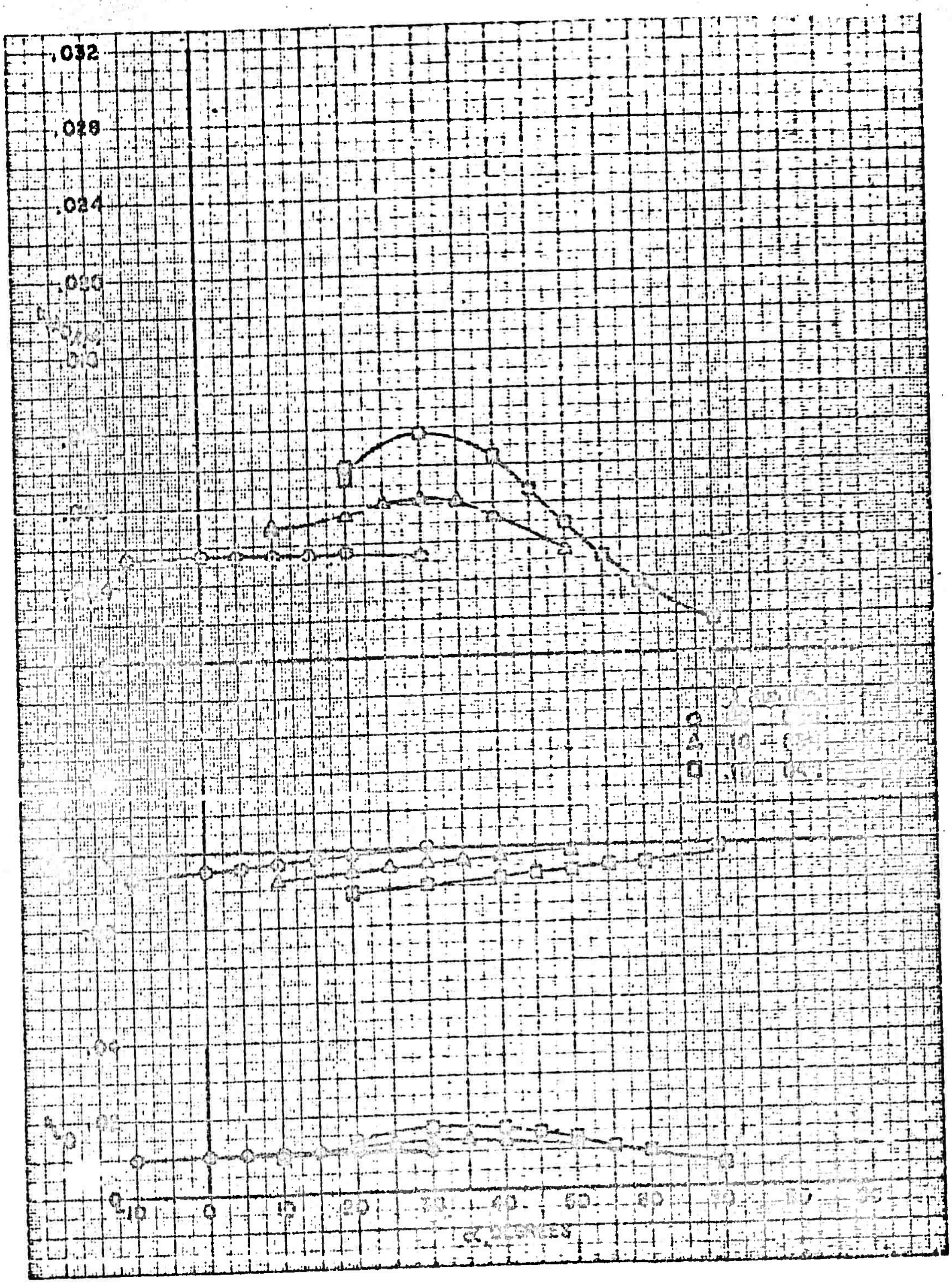

FIGURE 212 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3P_3SV_5$

$\beta = 12°$

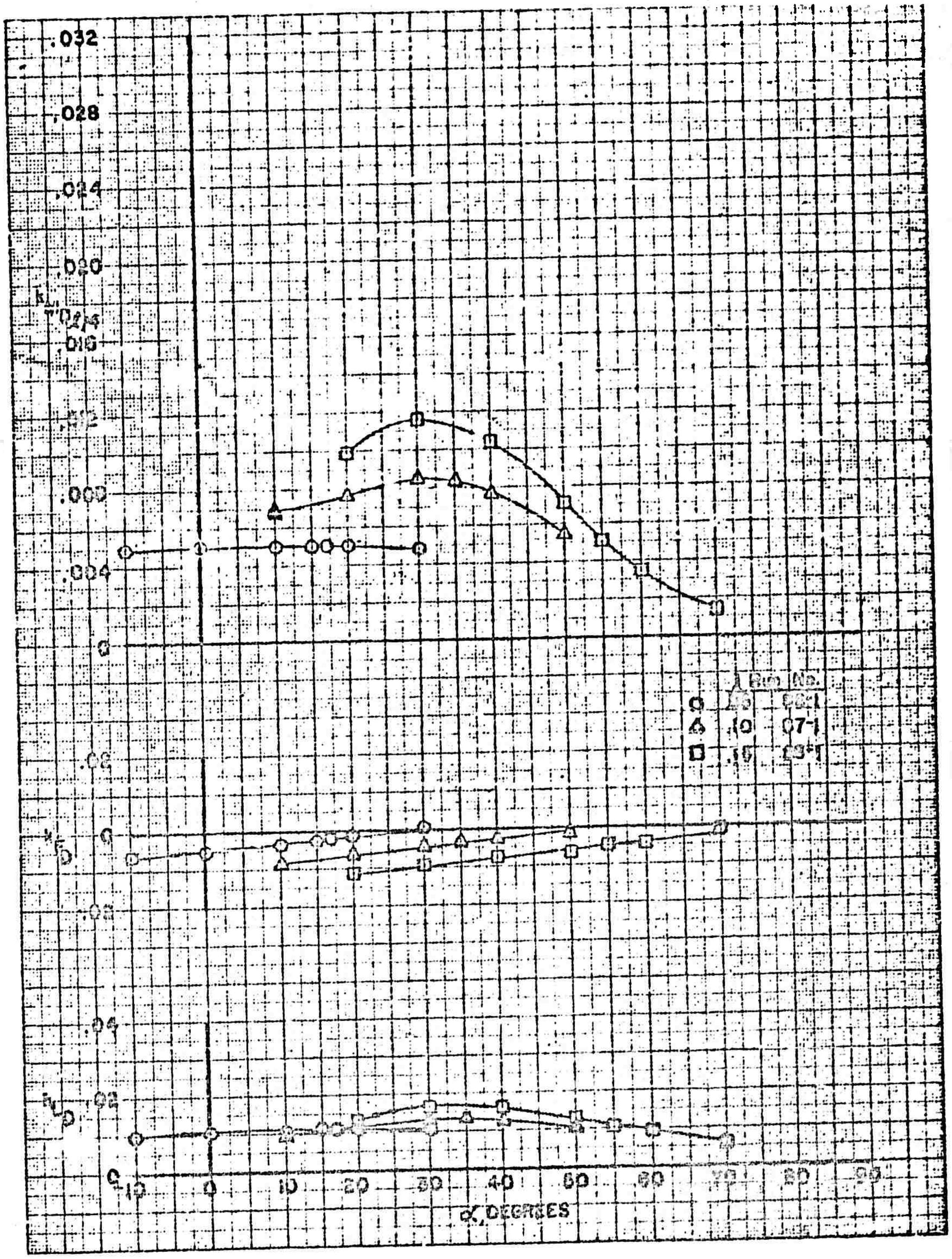

FIGURE 213 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

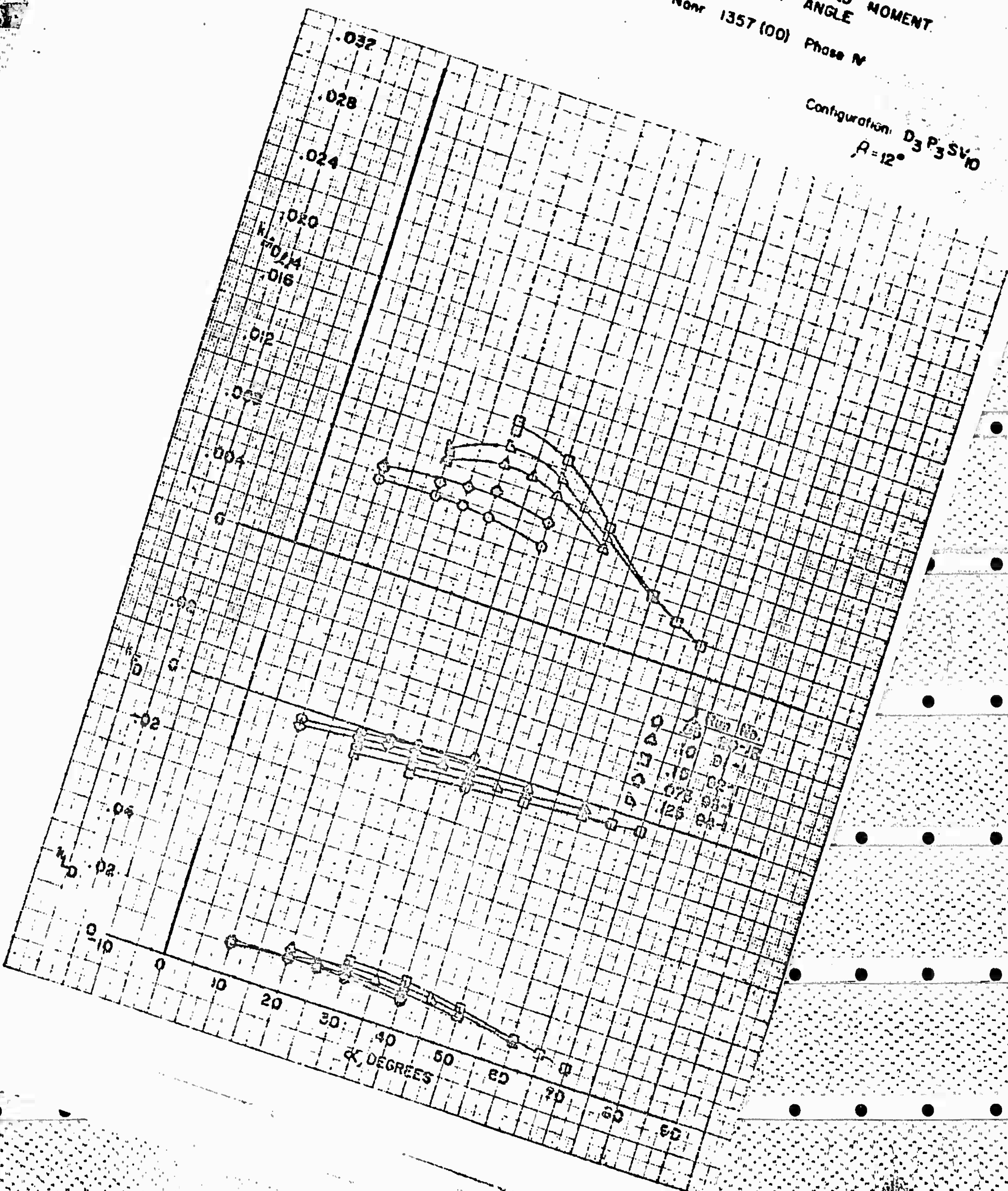

FIGURE 214 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: $D_3 P_3 SV_{15}$

$\beta = 12°$

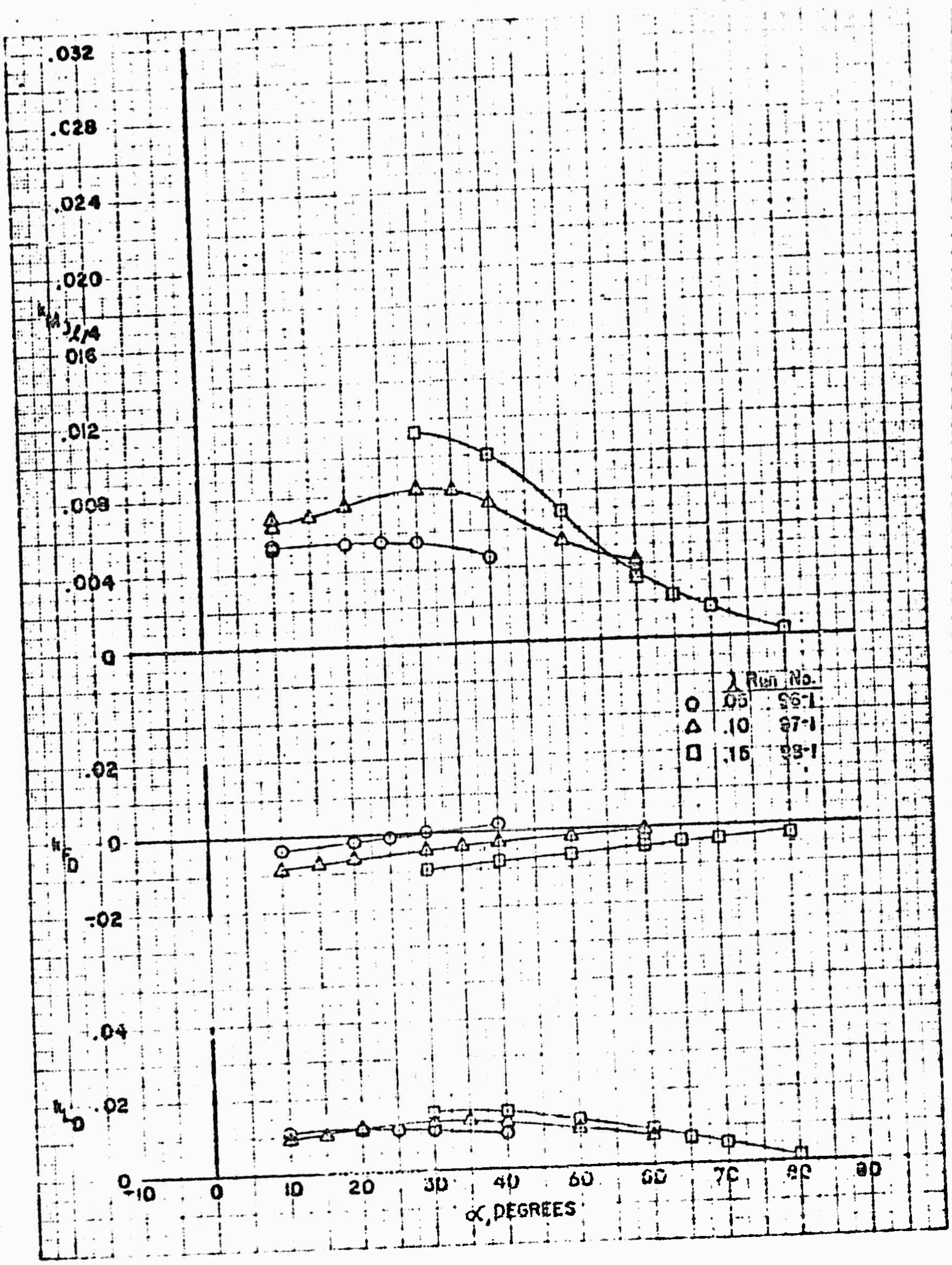

FIGURE 215 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_2SV_0$

$\beta = 18°$

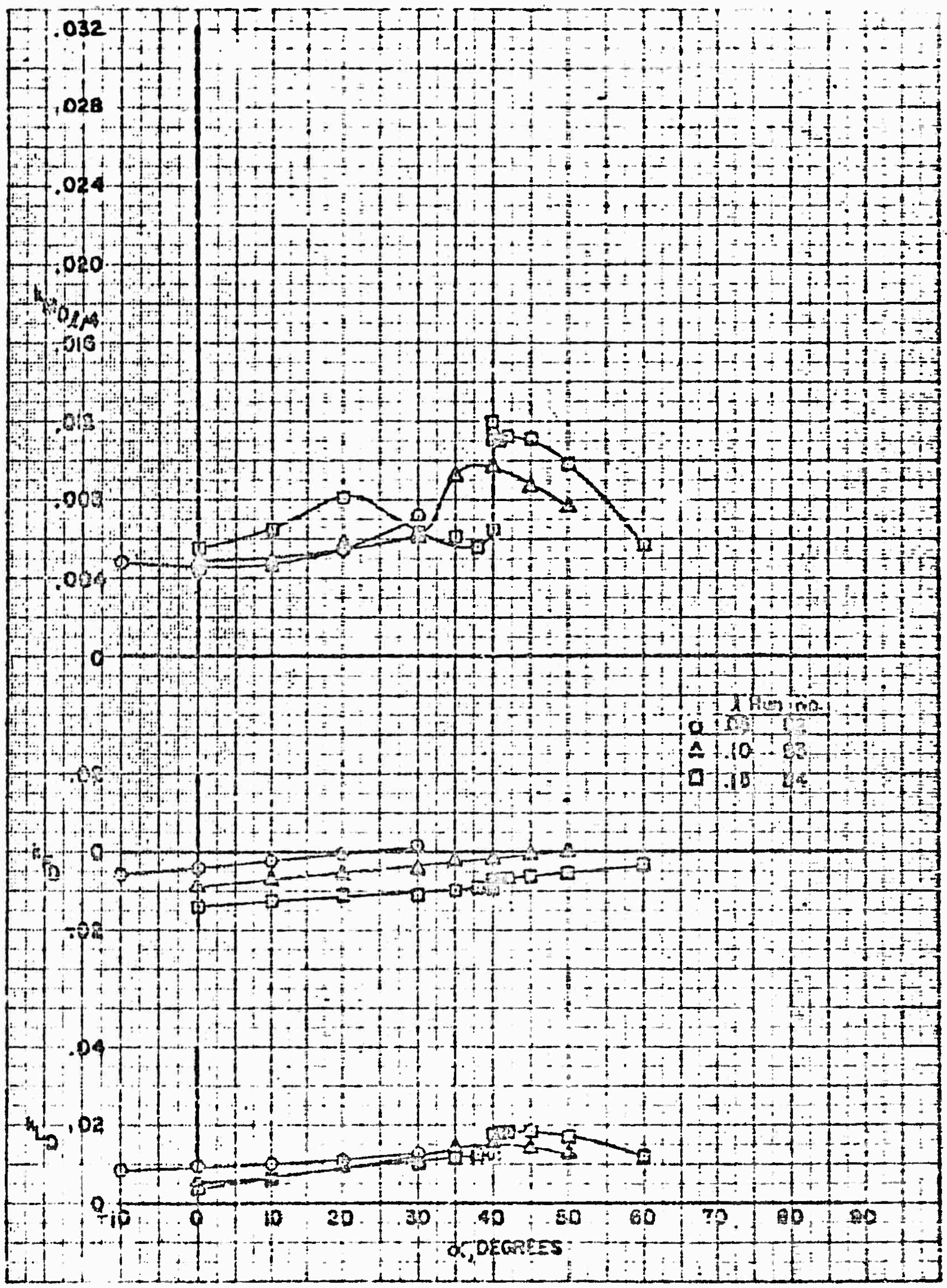

FIGURE 216 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3 F_3 H$

$\beta = 9°$

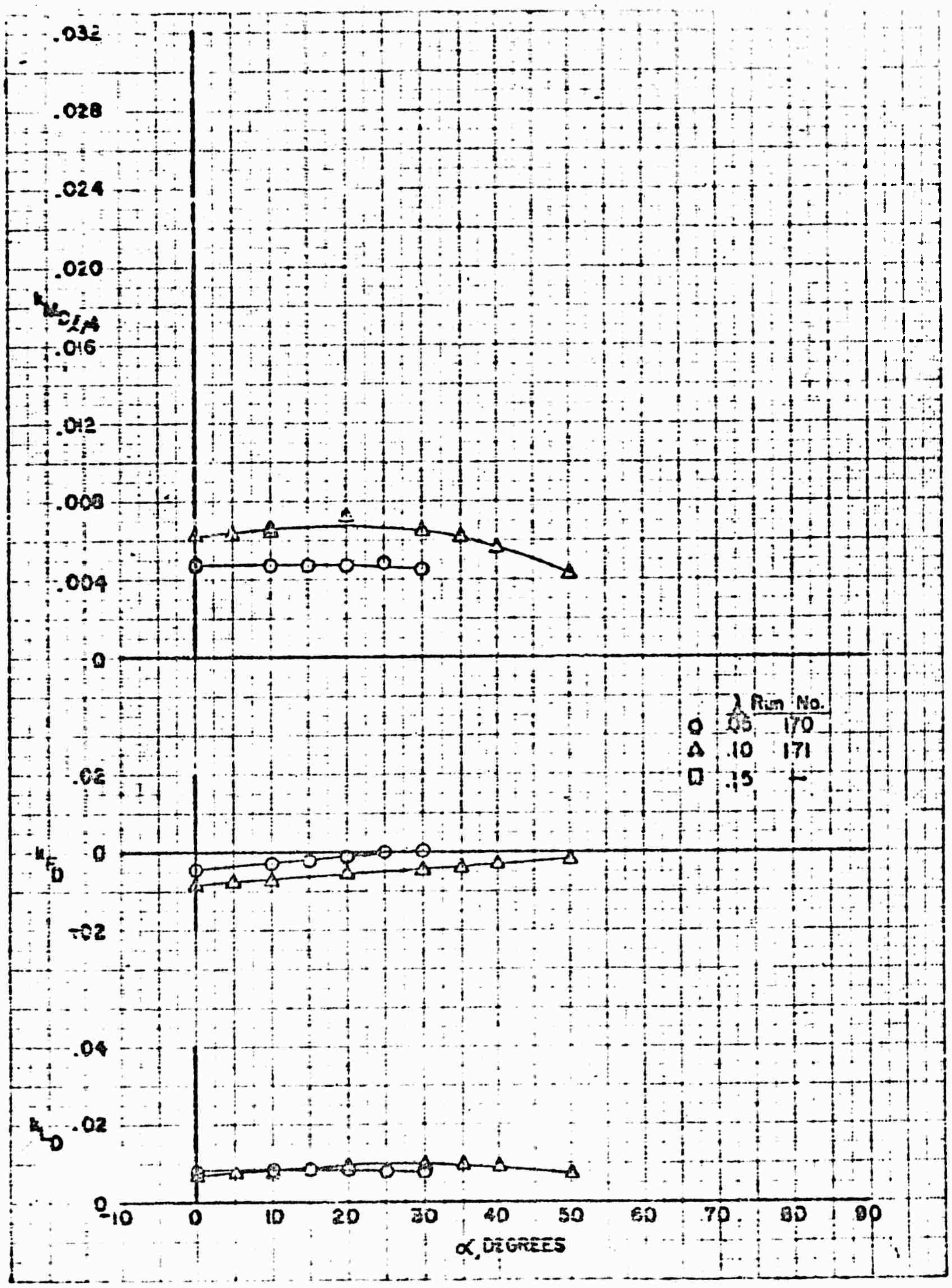

FIGURE 217 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

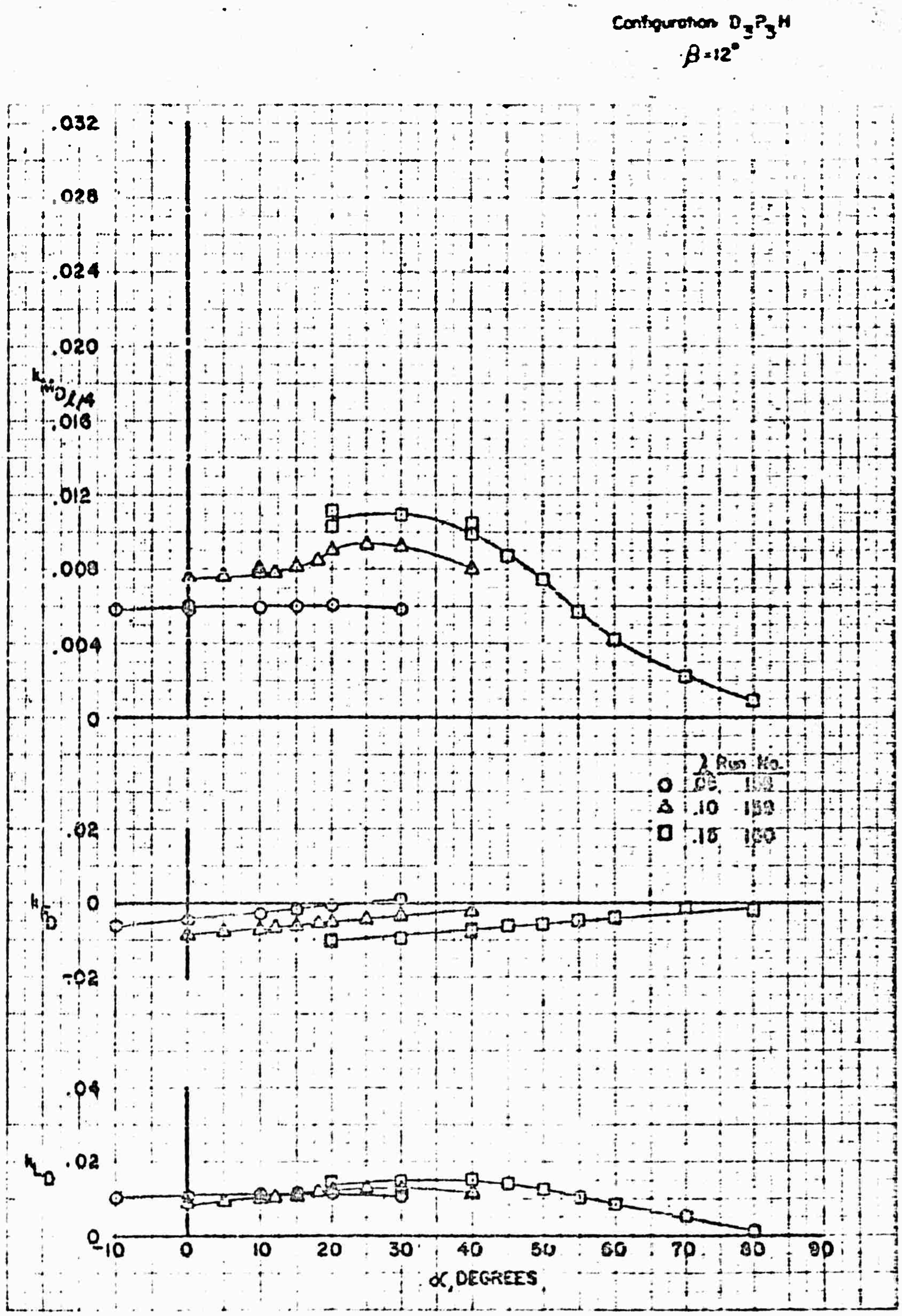

FIGURE 2.18 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

Configuration D_3P_3H

$\beta = 15°$

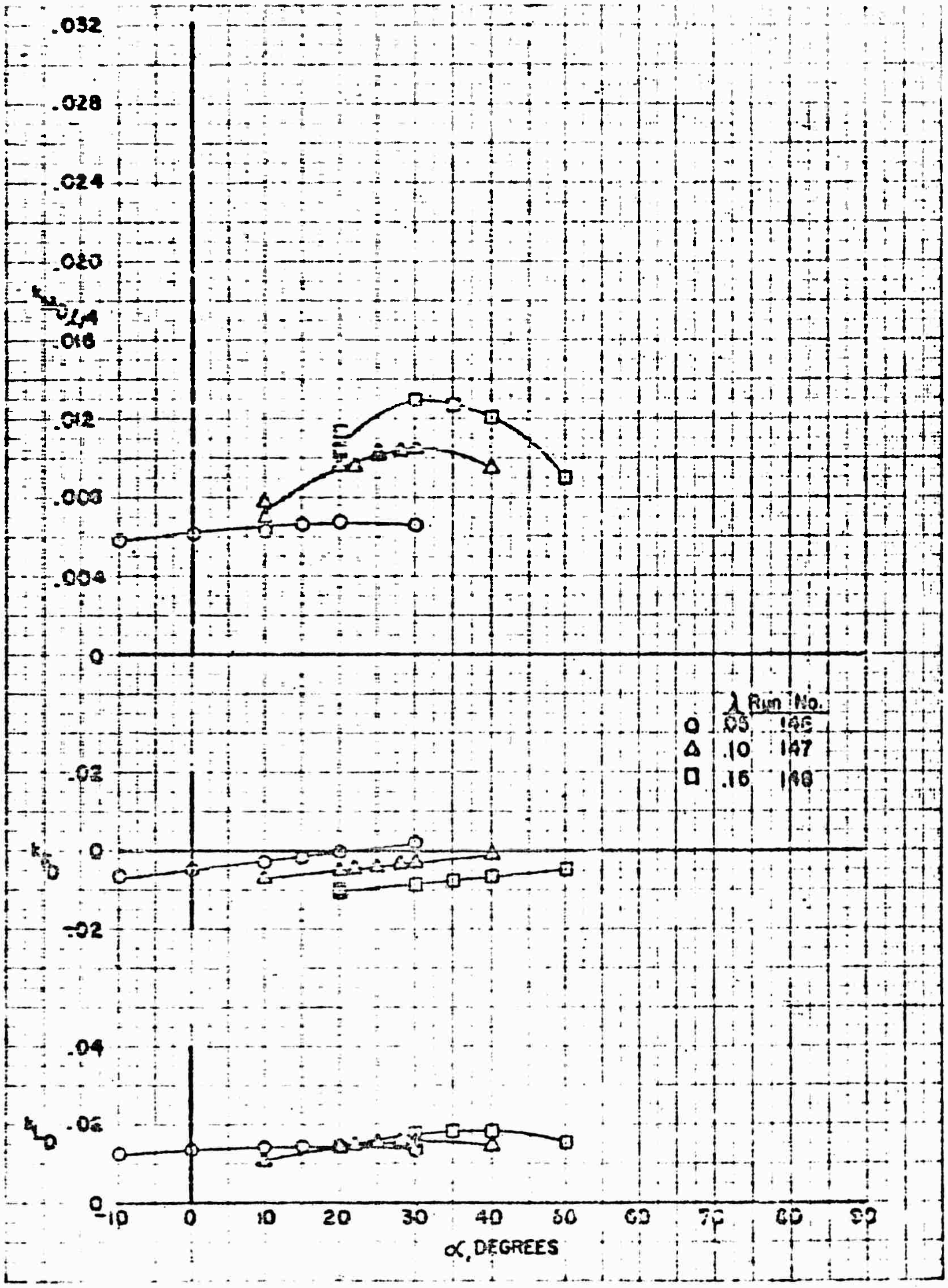

FIGURE 219 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration- D_3P_3HB
$\beta = 9°$

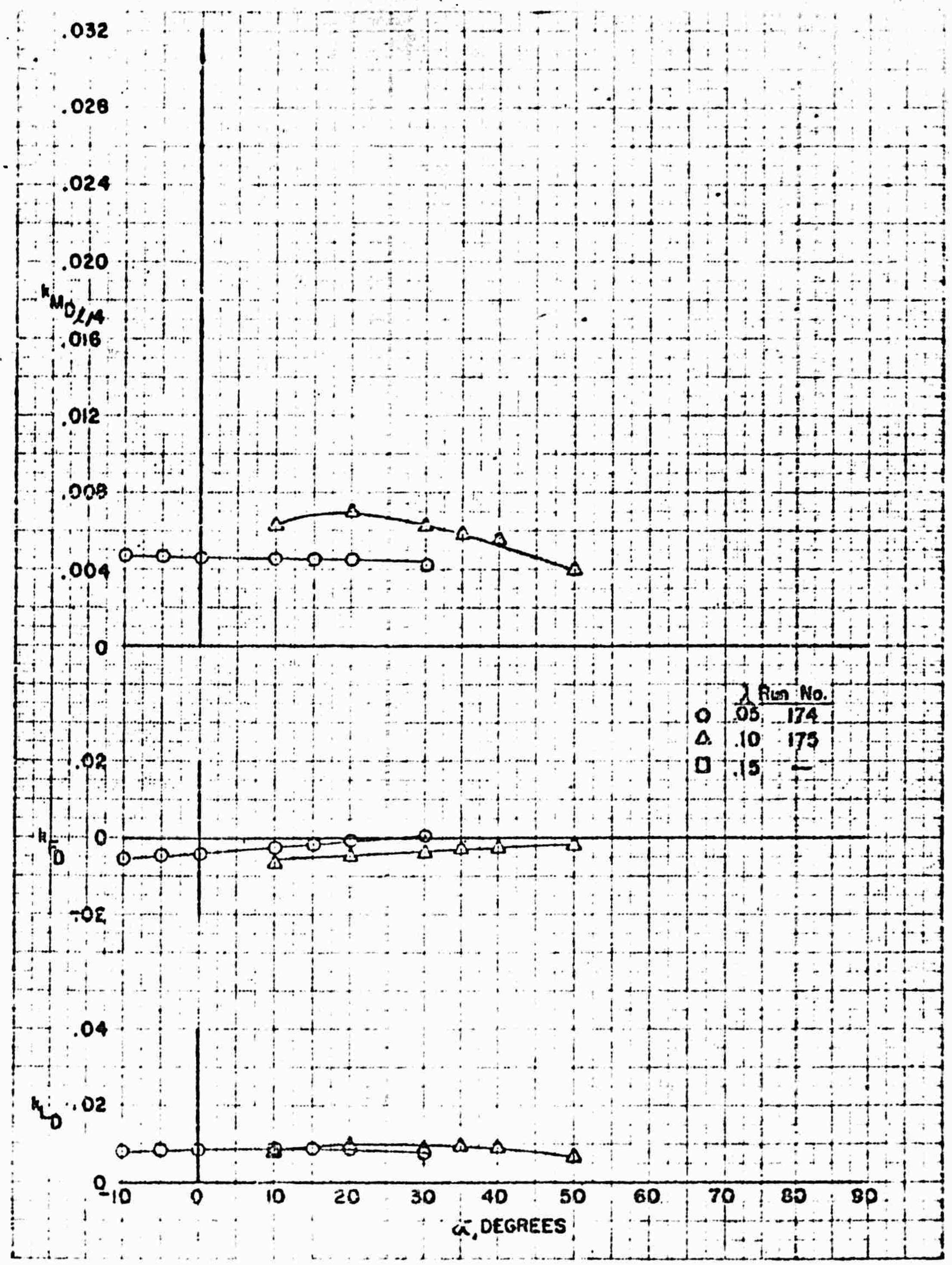

FIGURE 220 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (CC) Phase IV

Configuration D_3P_3HB

$\beta = 12°$

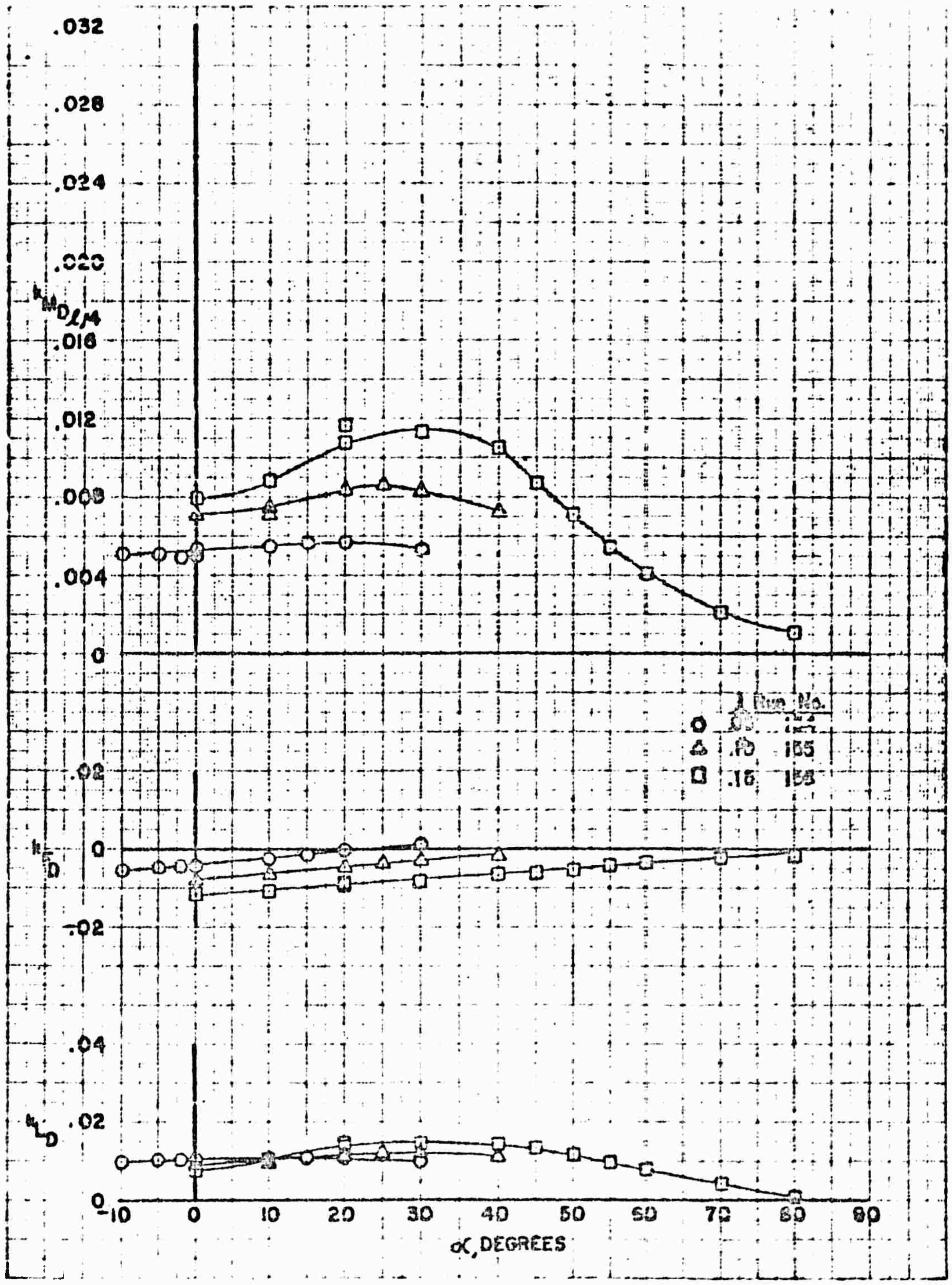

FIGURE 221 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr - 1357 (00) Phase IV

Configuration: D_3P_3HB

$\beta = 15°$

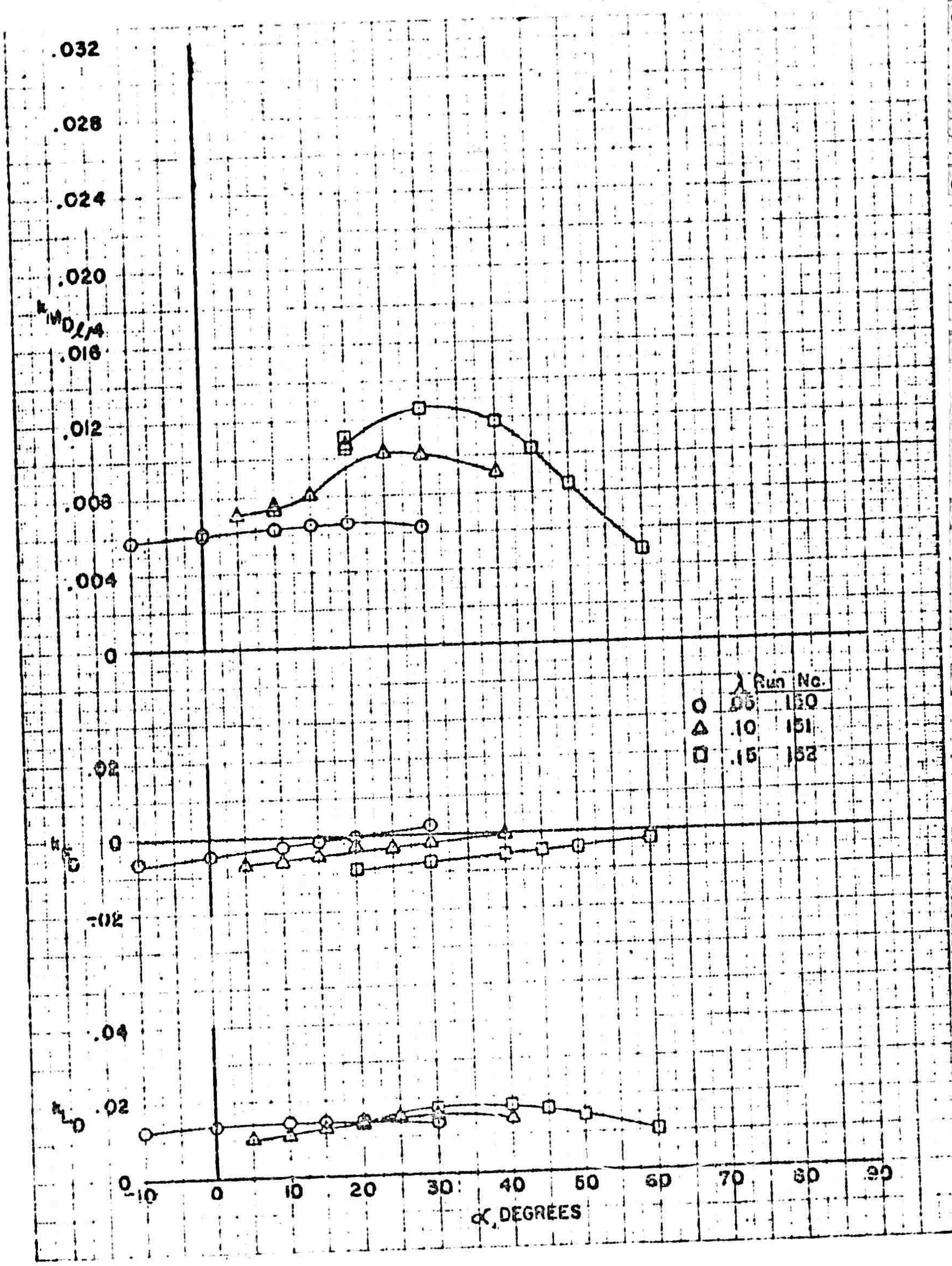

FIGURE 222 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

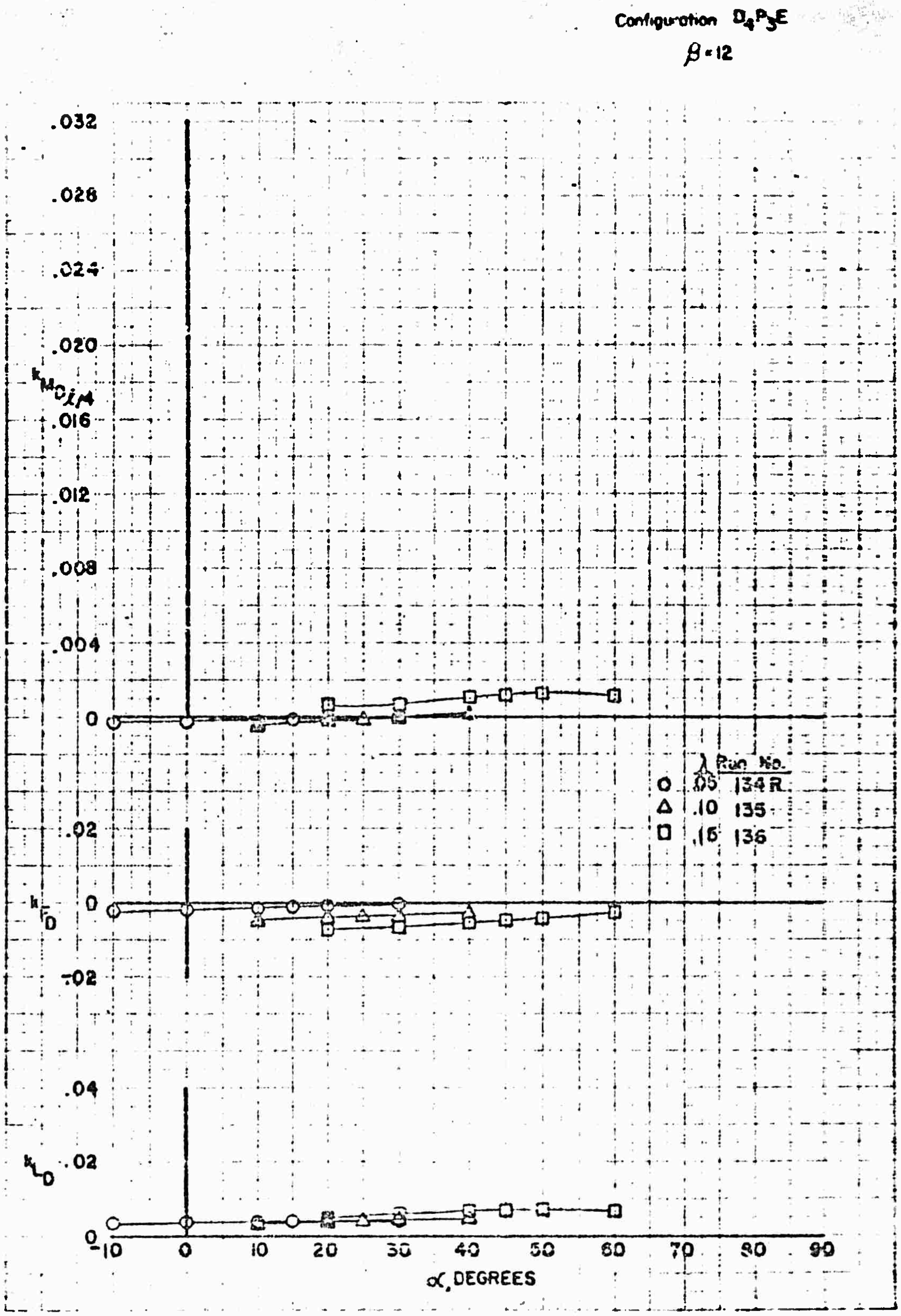

FIGURE 223 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_6P_3HE

$\beta = 12$

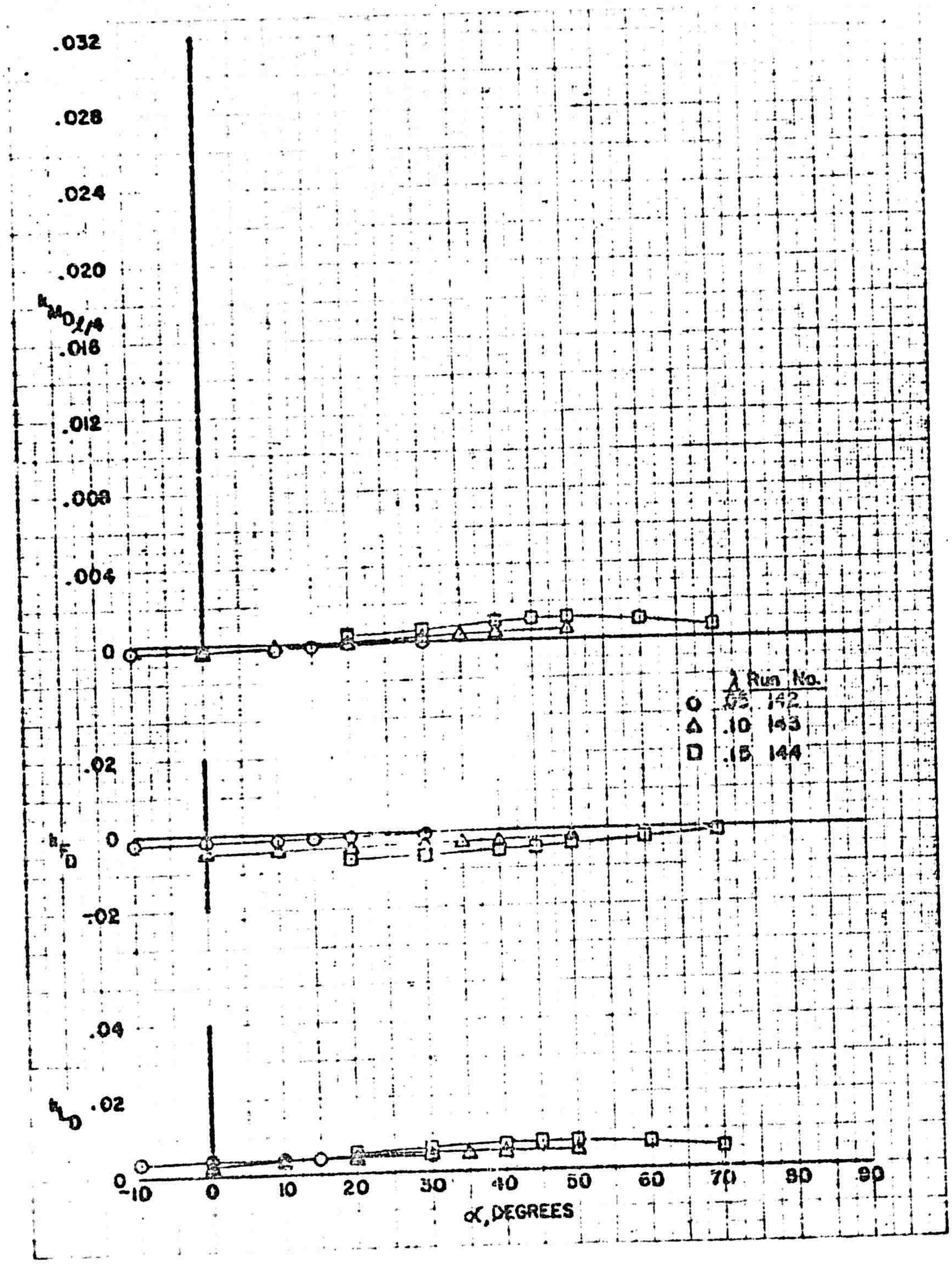

FIGURE 224 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (02) Phase IV

Configuration D_3P_3S $\Delta R = .088$

$\beta = 12°$ $\ell_p = 5.13$

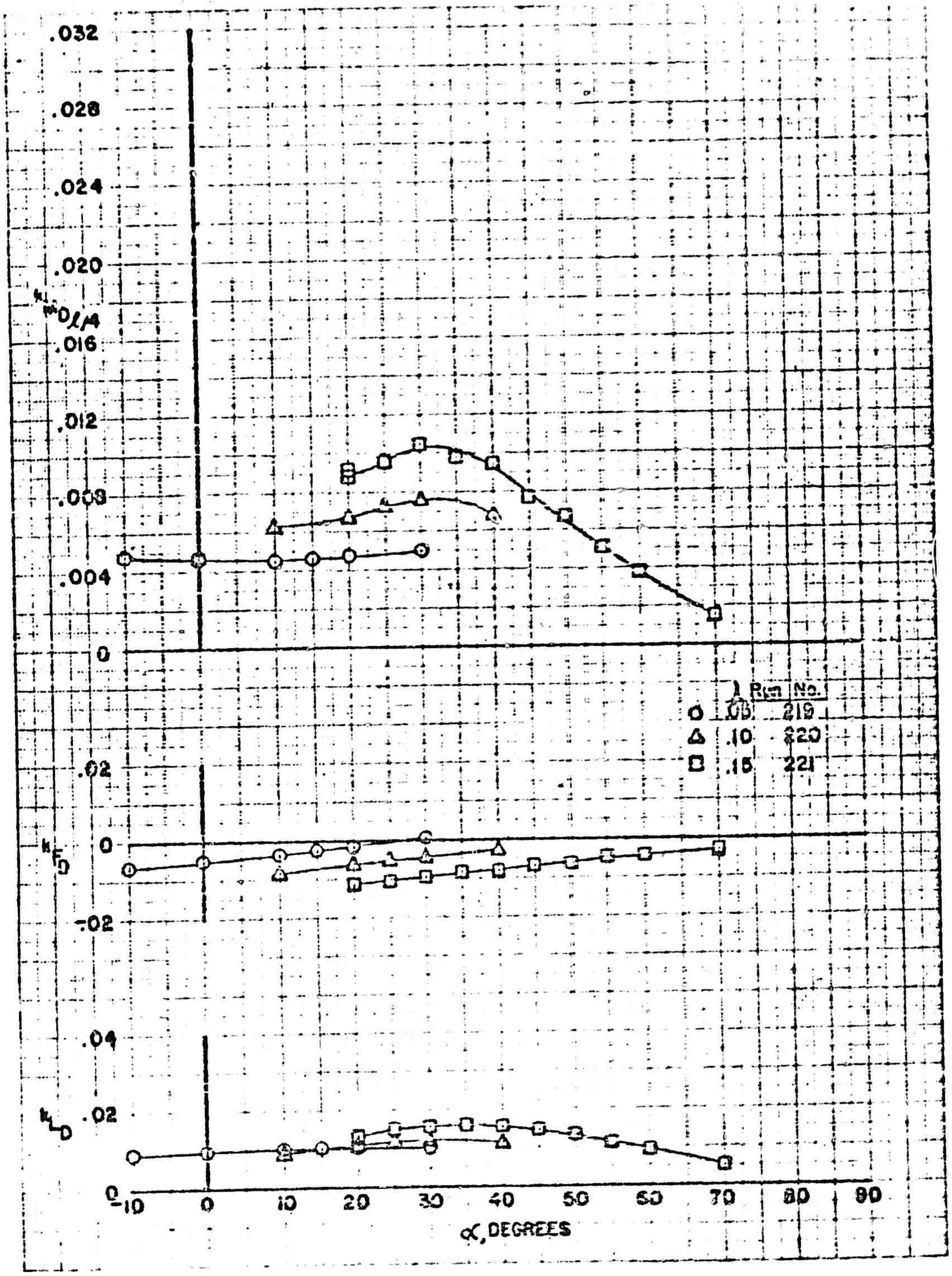

FIGURE 225 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration: D_3P_3S $\Delta R = .008$
$\beta = 18°$ $\ell_p = 5.13$

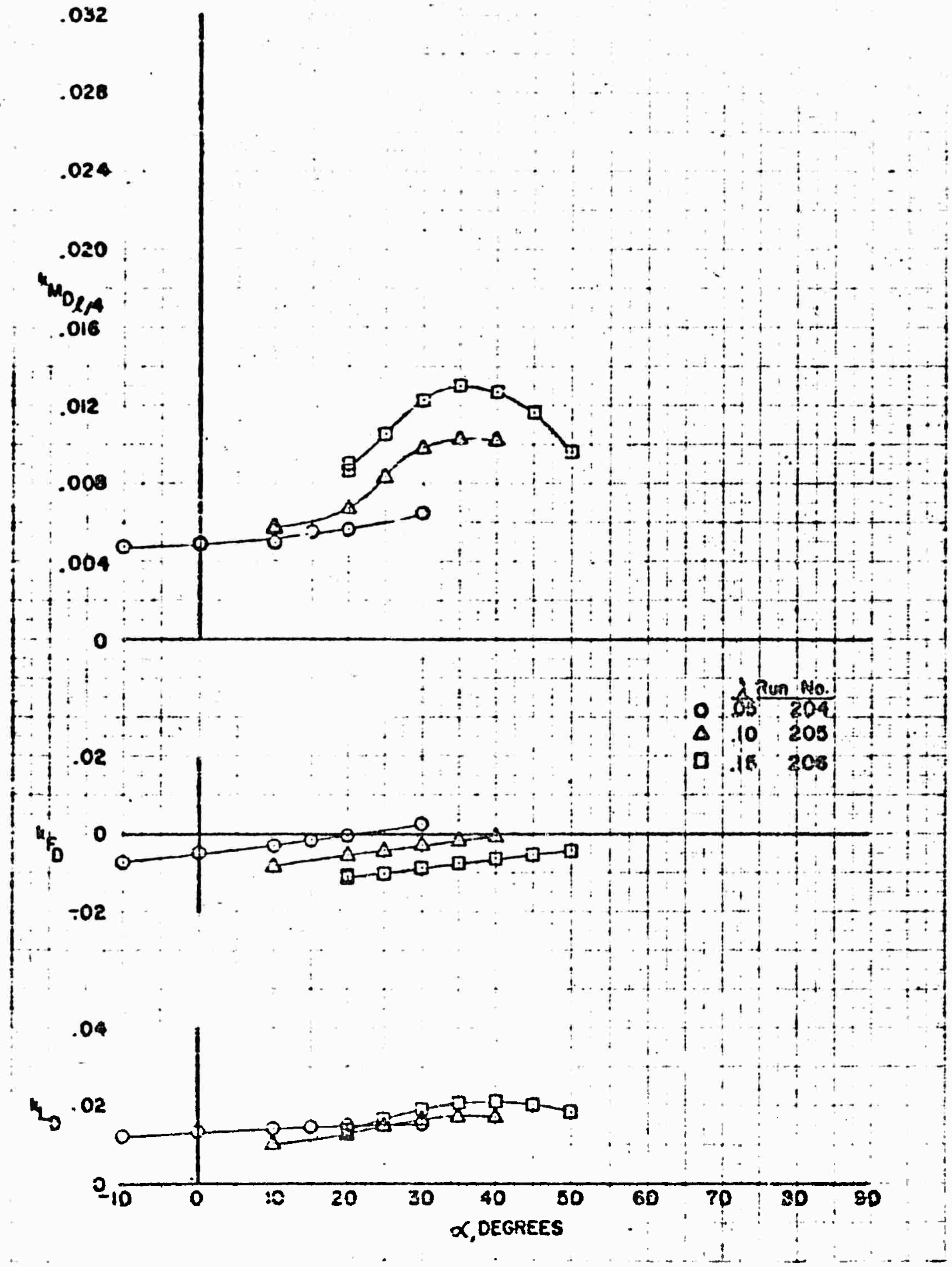

FIGURE 226 VARIATION OF DUCT FORCE AND MOMENT COEFFICENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

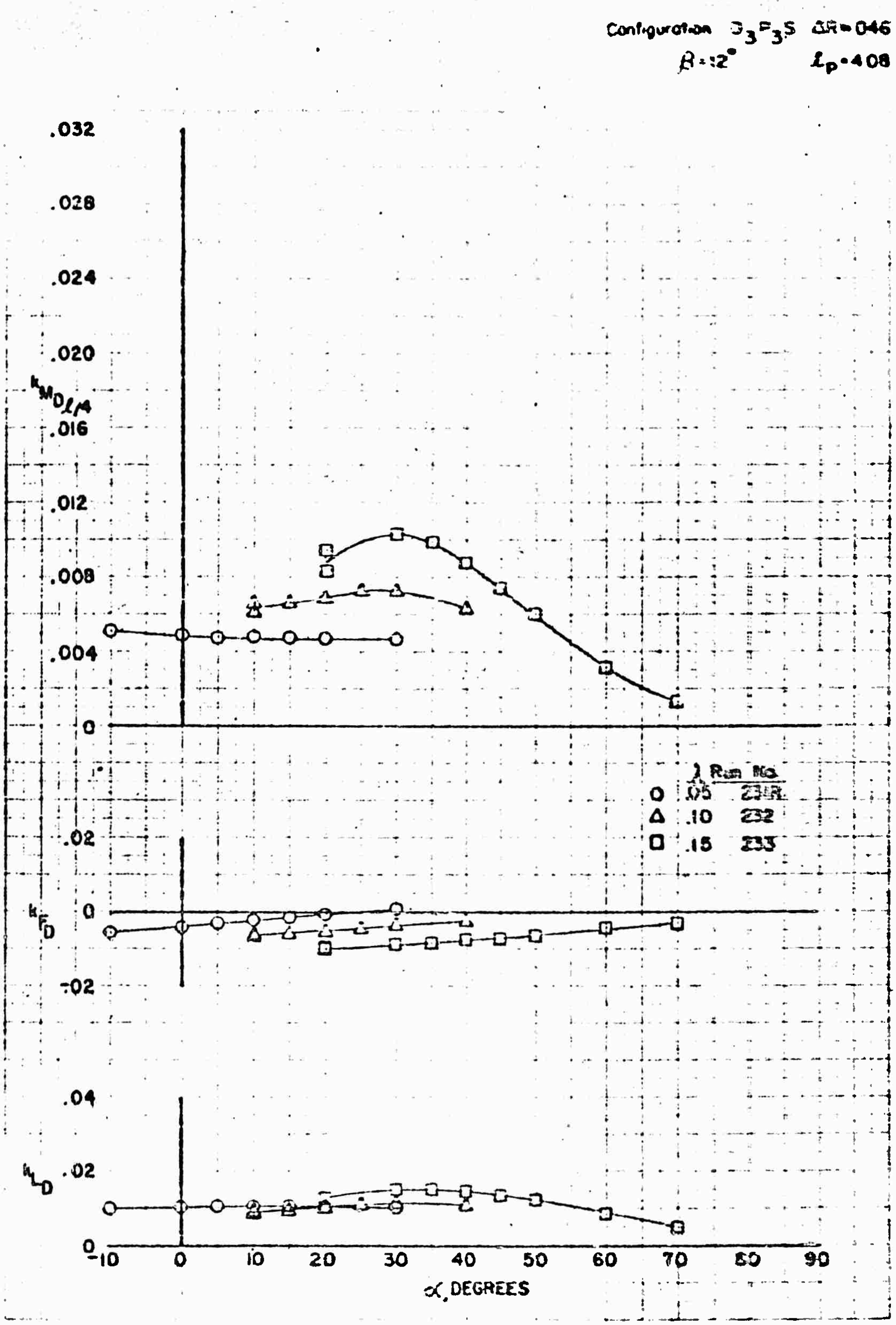

FIGURE 227 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

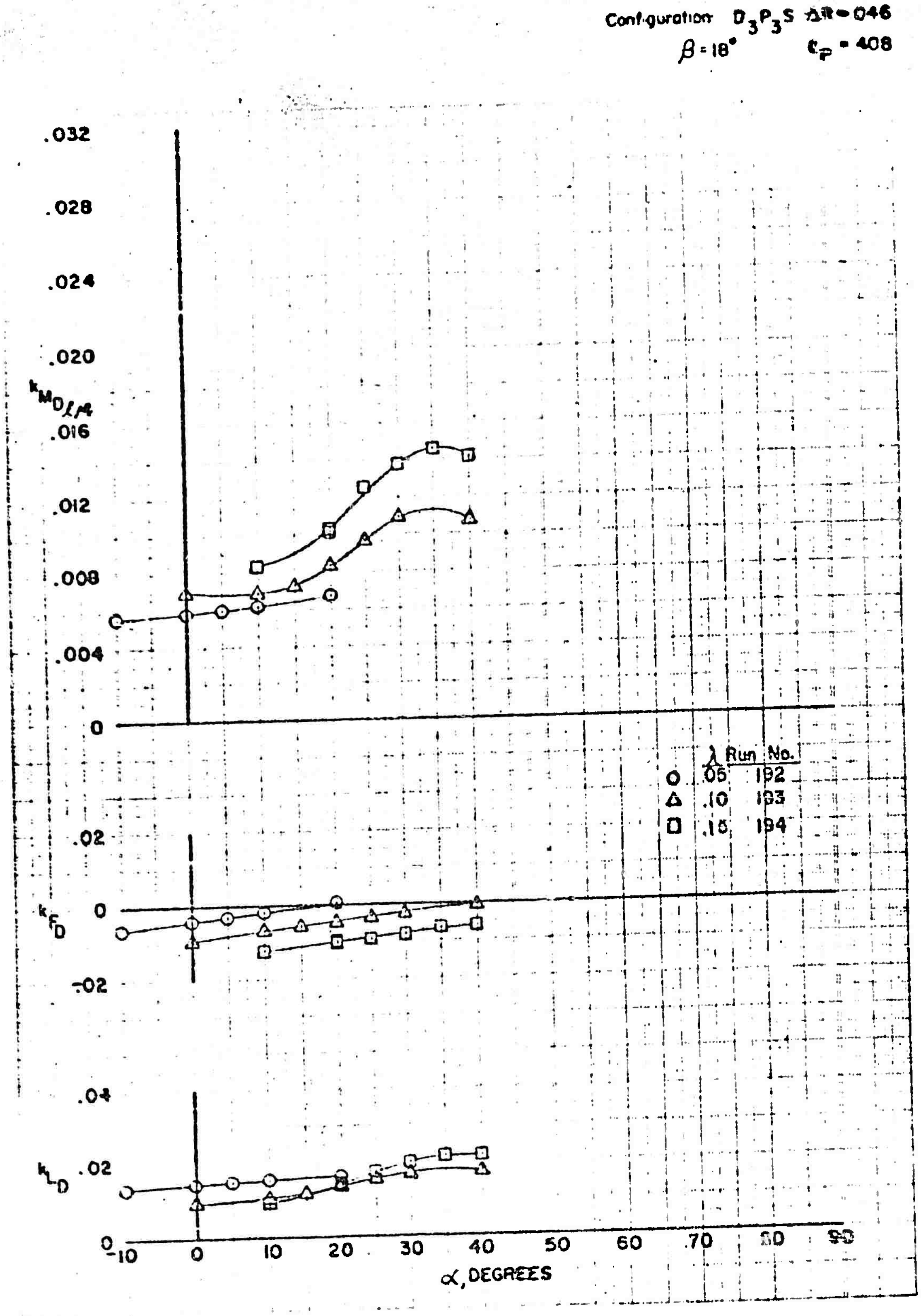

FIGURE 228 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S $\Delta R = .088$

$\beta = 12°$ $\ell_p = 4.08$

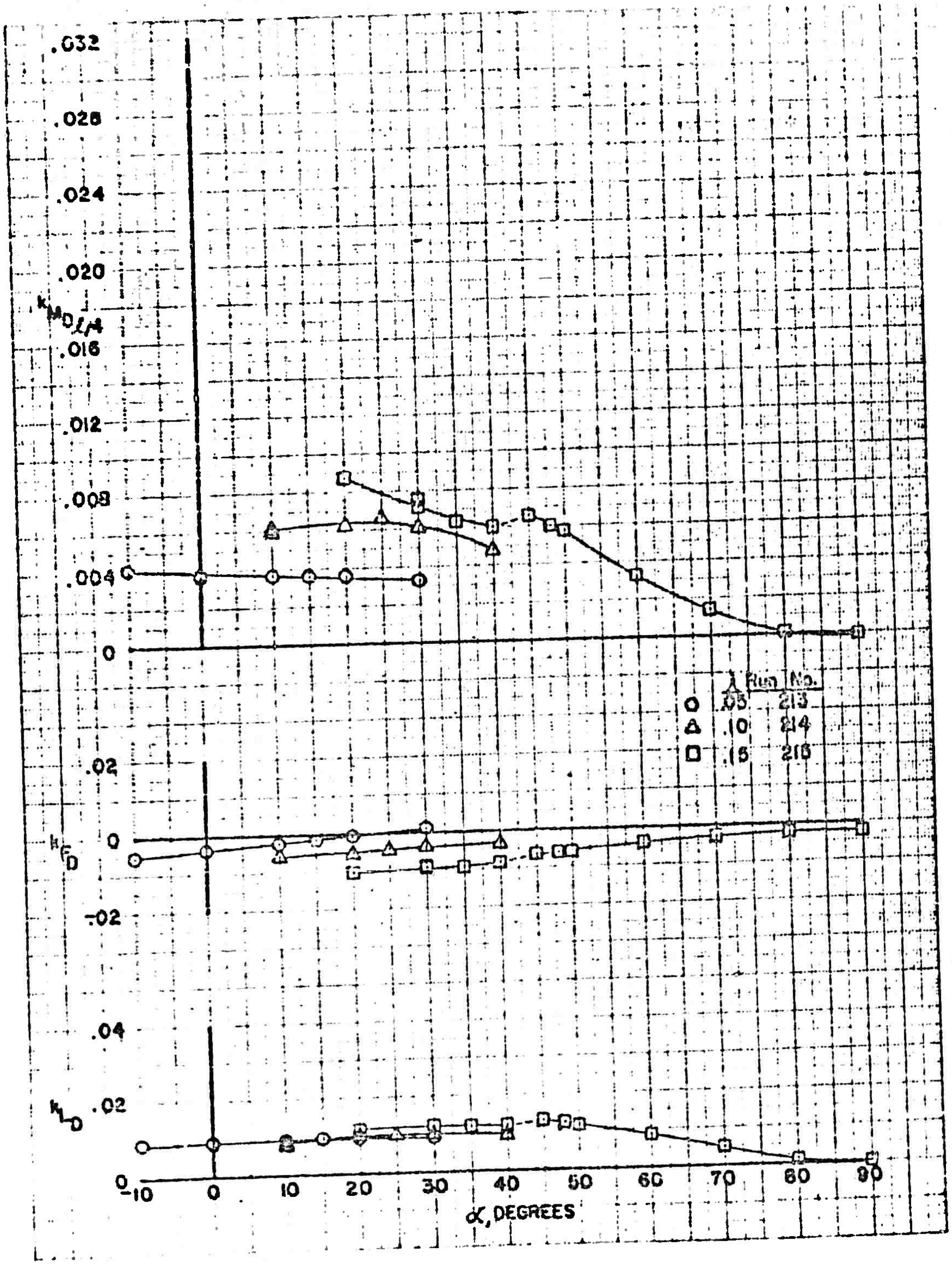

FIGURE 229 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_3P_3S $\Delta R = .088$

$\beta = 18°$ $\ell_p = 4.08$

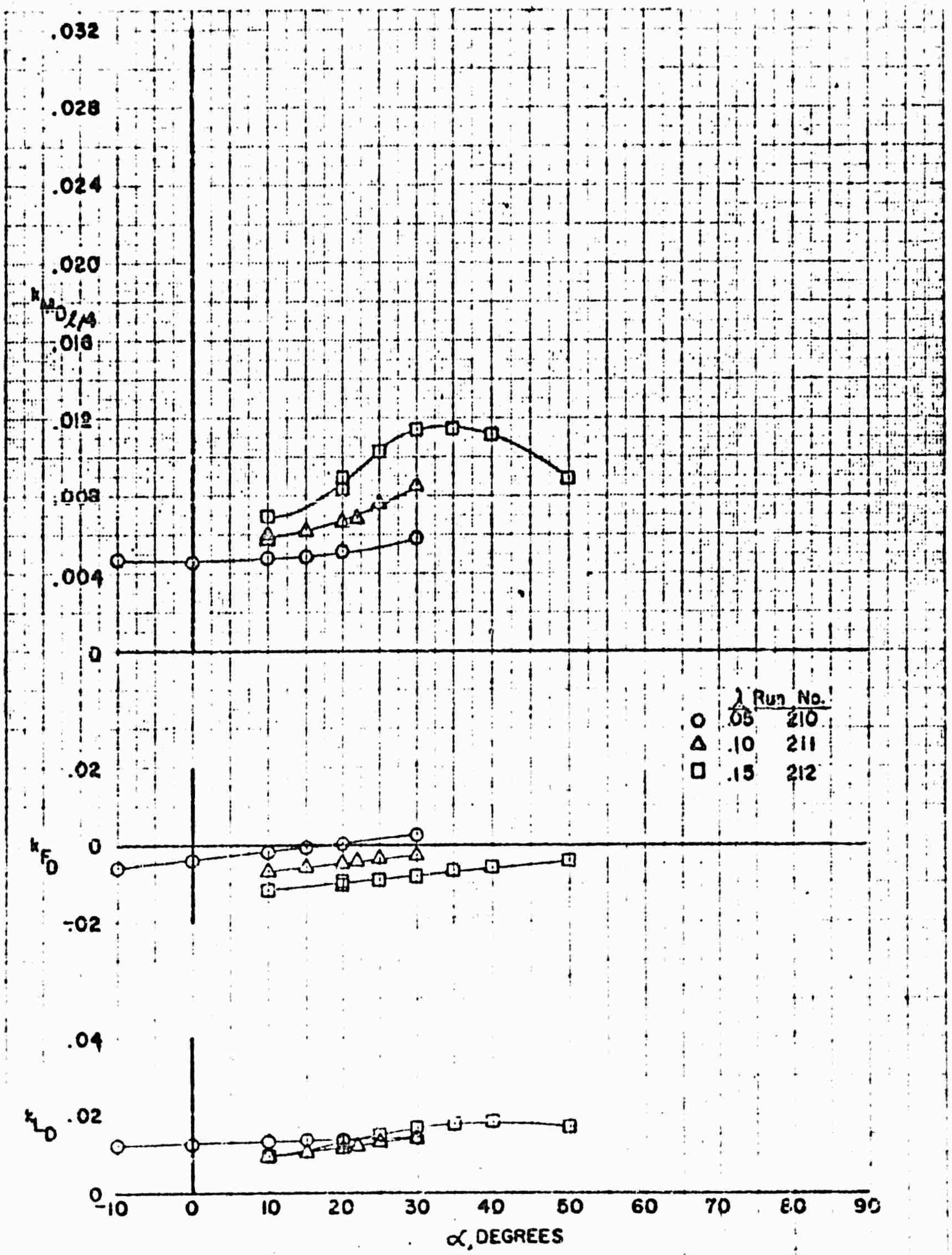

FIGURE 230 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

Configuration $D_3P_3'S$ $\Delta R \approx .046$

$\beta = 12°$ $\ell_p = 2.59$

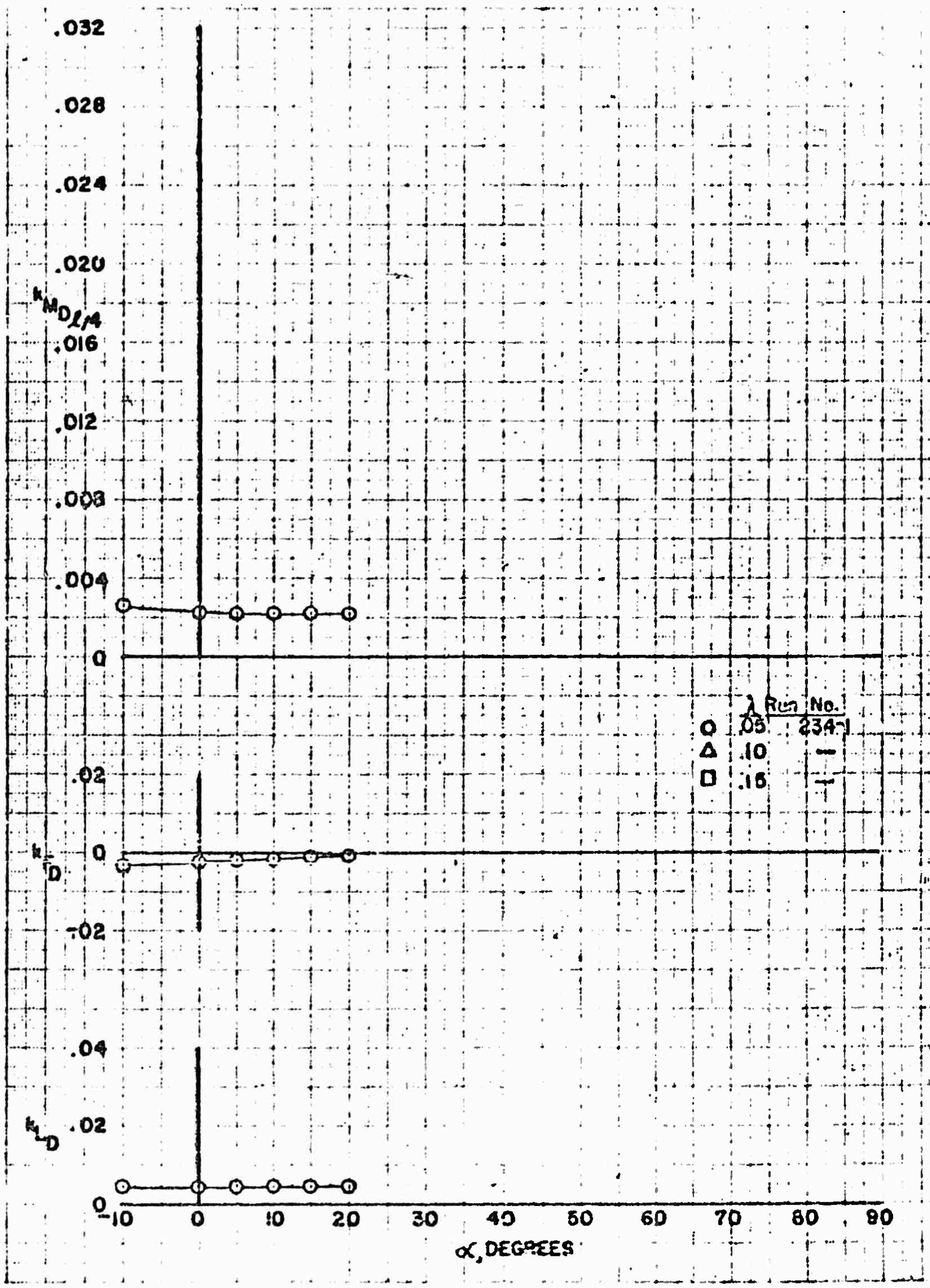

FIGURE 23: VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

Configuration $D_3P'_3S$ $\Delta R = .046$
$\beta = 21°$ $\mathcal{L}_p = 2.59$

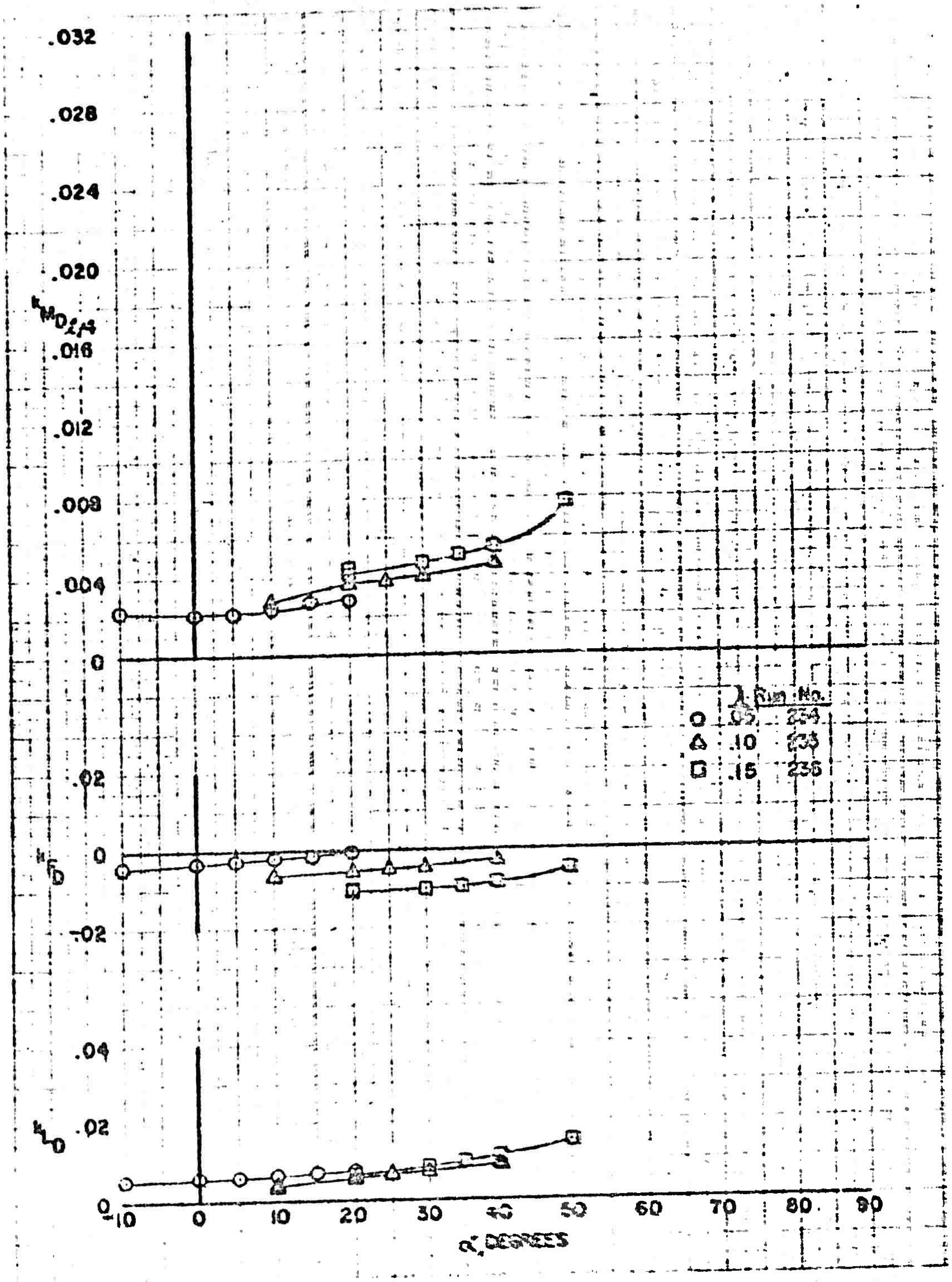

FIGURE 232 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration $D_3P_3'S$ ΔR = .046
β = 30° ℓ_p = 2.59

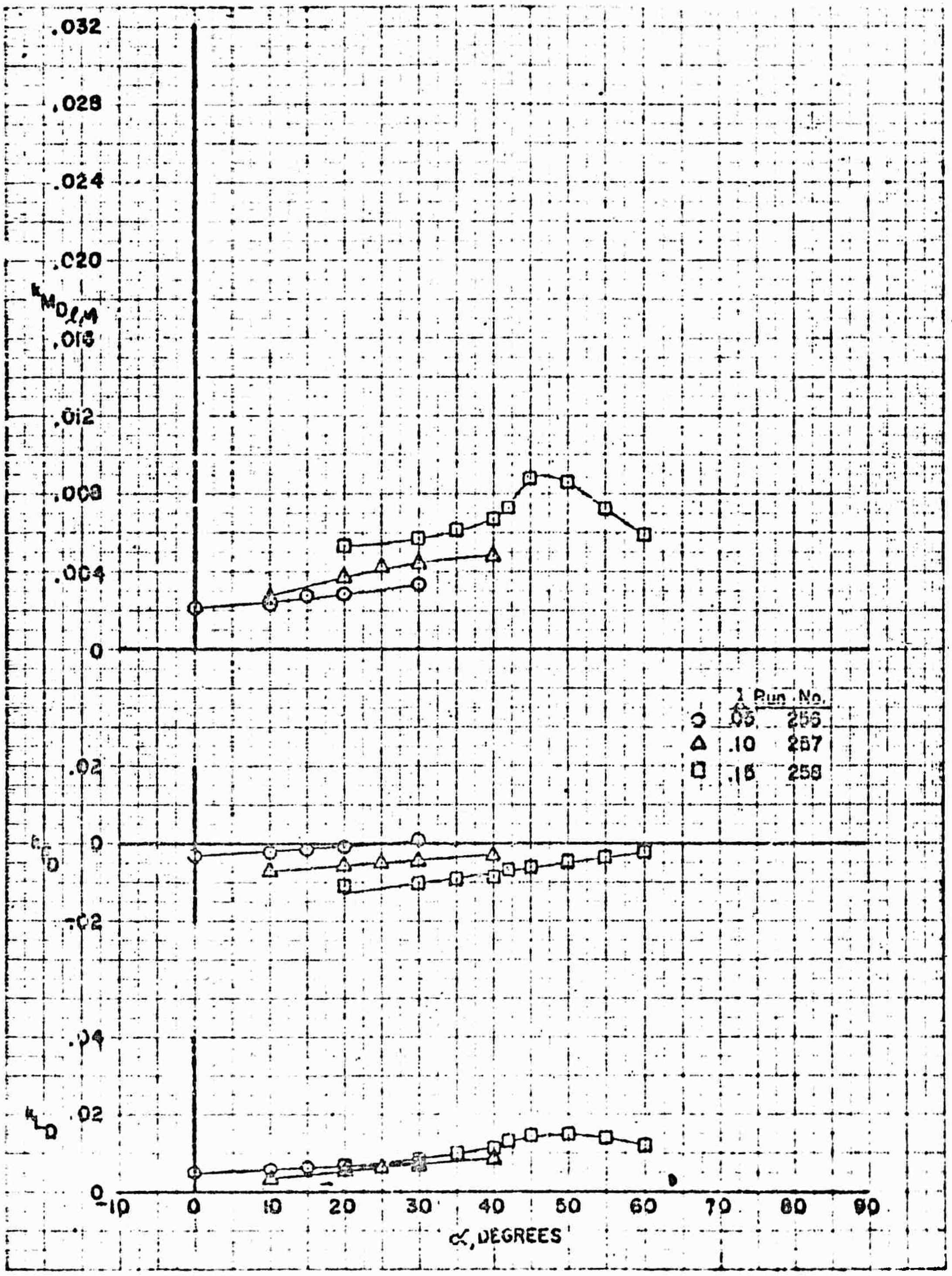

FIGURE 233 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (01) Phase IV

Configuration $D_3P_3'S$ ΔR = .088

β = 30° ℓ_p = 2.59

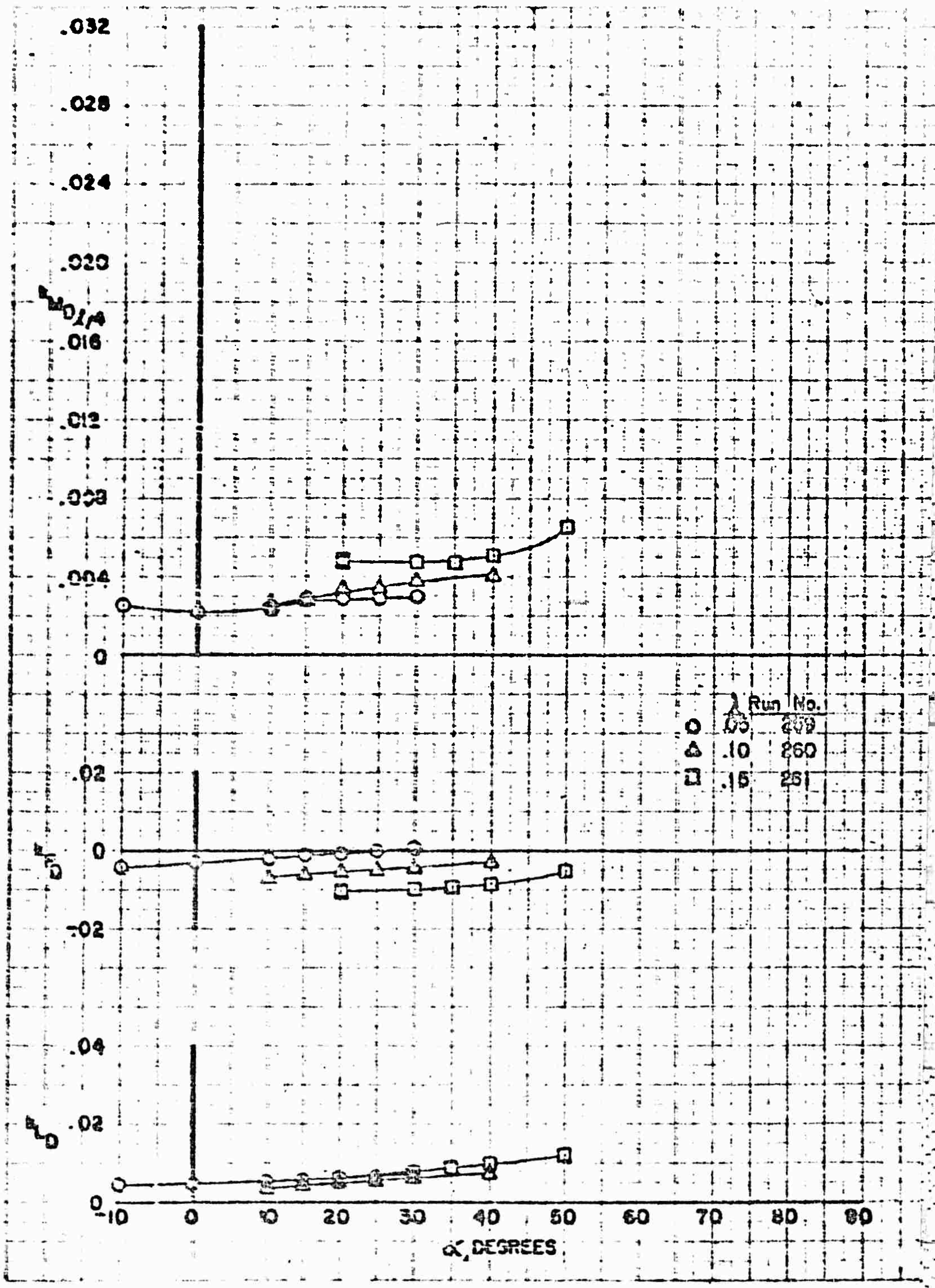

FIGURE 234 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_4P_3S
$\beta = 30°$

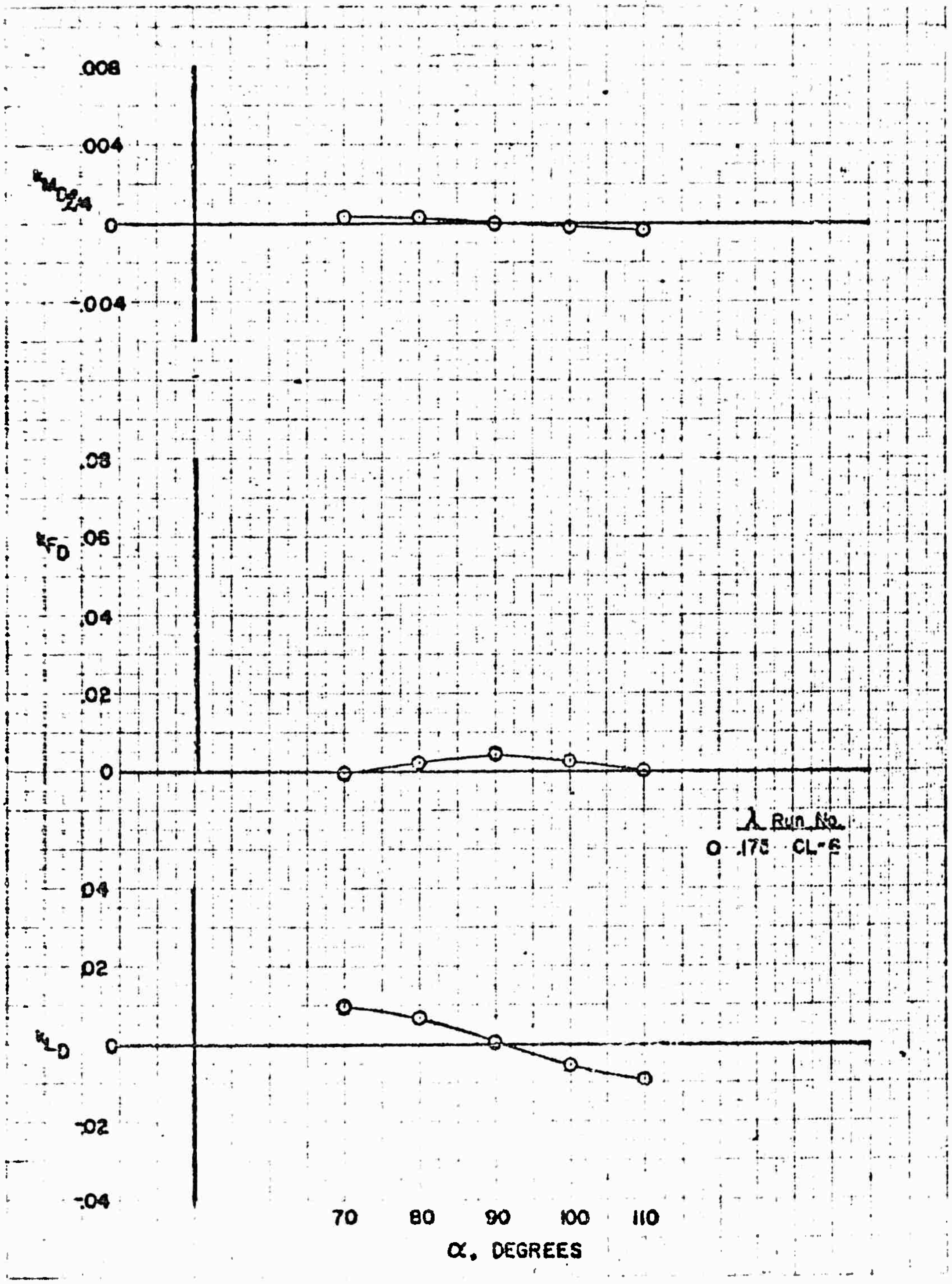

FIGURE 235 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357(00) Phase IV

Configuration D_3P_2S

$\beta = 12°$

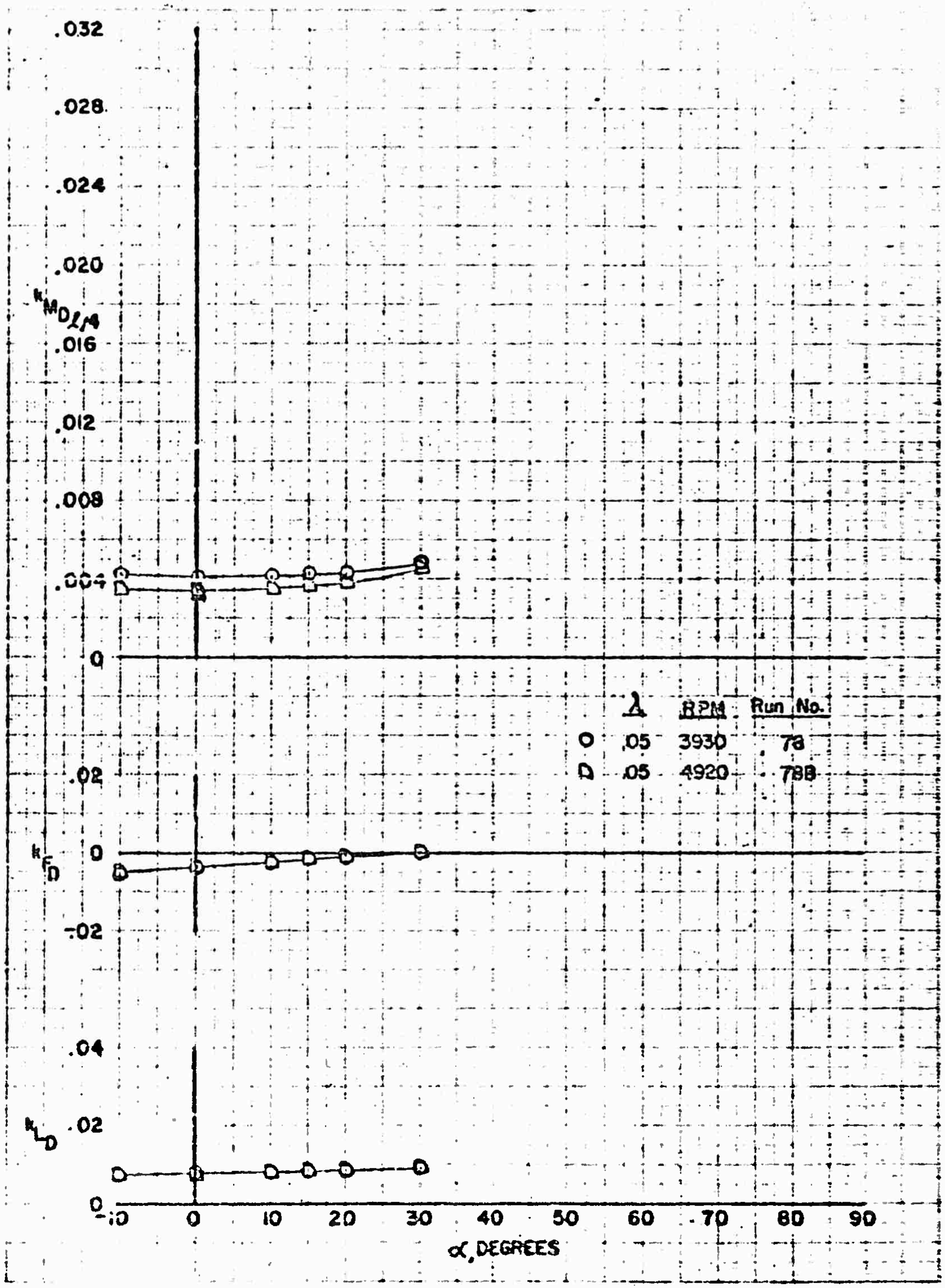

FIGURE 236 VARIATION OF DUCT FORCE AND MOMENT COEFFICIENTS WITH TILT ANGLE

Contract Nonr 1357 (00) Phase IV

Configuration D_1